THE SOUTHWESTERN NATURALIST

VOLUME 1 NUMBER 3 July, 1956

THE SOUTHWESTERN ASSOCIATION OF NATURALISTS

President

ROBERT G. LINDEBORG (*Animal Ecology*),
New Mexico Highlands University

Vice President

W. H. HORR (*Plant Ecology*)
University of Kansas

Secretary-Treasurer

RUSSELL W. STRANDTMANN (*Zoology*),
Texas Technological College

Editor

LLOYD H. SHINNERS (*Botany*)
Southern Methodist University

Board of Governors

Class of 1957

CARL D. RIGGS (*Fishery Biology*),
University of Oklahoma

U. T. WATERFALL (*Plant Taxonomy*),
Oklahoma A&M College

Class of 1958

WILLIAM K. CLARK (*Vertebrate Zoology*),
Sam Houston State Teachers College

HERNDON G. DOWLING (*Herpetology*),
University of Arkansas

Class of 1959

ALBERT P. BLAIR (*Herpetology*),
University of Tulsa

DOROTHY V. LEAKE (*Phycology*),
Southeastern (Oklahoma) State College

Class of 1960

HOWARD MCCARLEY (*Mammalogy*)
Stephen F. Austin State College

MARSHALL R. WHEELER (*Entomology*)
University of Texas

Founded in May, 1953, "to promote the field study of plants and animals, living and fossil, in the Southwestern United States and Mexico, and to aid the scientific activities of its members," the Association holds an annual meeting with field trips, issues a newsletter, SWANEWS, and publishes THE SOUTHWESTERN NATURALIST. Membership is open to all persons interested in the natural history of Arizona, Arkansas, Kansas, Louisiana, New Mexico, Oklahoma, Texas and Mexico. Application should be made to the Secretary-Treasurer. Dues are $2 per year for regular members, $4 for sustaining members.

THE SOUTHWESTERN NATURALIST

Published by the Southwestern Association of Naturalists, four times a year, at Dallas, Texas. Subscriptions to members, $2 per year (in addition to dues; payable with dues directly to the Secretary-Treasurer); to non-members, $4 per year (enter non-member subscriptions with the Editor, making checks or money orders payable to the Southwestern Association of Naturalists). Single issues are not sold separately. Publication is not available in exchange.

The Southwestern Naturalist is open to papers dealing largely or exclusively with the natural history of the Southwestern United States and Mexico. Articles in English or Spanish on the taxonomy, geography, ecology, and evolution of living or fossil organisms of the region are acceptable, as are bibliographical, historical, and biographical articles which contribute to investigations in these fields. Priority is given to manuscripts submitted by members of the Association. Information for contributors is given inside the back cover.

THE SOUTHWESTERN NATURALIST 1 (3): 97---99 JULY, 1956

SIGNIFICANCE OF ORTHOGENESIS IN ANGIOSPERM TAXONOMY[1]

ARTHUR CRONQUIST

New York Botanical Garden, Bronx Park, New York 58

ABSTRACT. Higher categories of vertebrate animals (especially Reptilia. Aves, Mammalia, and orders within the Mammalia) are readily distinguished by structural features showing adaptation to environment. The more numerous higher categories among angiosperms, on the contrary, are distinguished by combinations of many structural features showing no apparent adaptation to environment. Darwinian evolution is prominent at all taxonomic levels among the higher vertebrate animals. Orthogenetic evolution is prominent at higher taxonomic levels among angiosperms, while Darwinian evolution apparently is operative chiefly at the rank of genus and below. The great difference in the ease with which higher animal categories can be recognized and handled taxonomically as compared with corresponding categories among the flowering plants is the consequence of a fundamental difference in the prevailing mode of evolution.

The difficulty with which the higher categories of angiosperms are recognized stands in sharp contrast to the relative ease with which such categories are discerned in the mammals, or in vertebrates as a whole. The three classes of essentially land vertebrates, the Reptilia, Aves, and Mammalia, are pretty clear even to the unlearned. Such mammalian orders as the chiroptera (bats(, Primates, Rodentia, Lagomorpha (rabbits and hares), Carnivora, Pinnipedia (seals and walruses), Proboscidea (elephants), Perissodactyla (horses, etc.), Artiodactyla (cloven-hoofed animals), and Cetacea (whales and porpoises) are familiar to and readily recognized by a great many laymen, even though they may never have heard of the scientific ordinal names. Likewise such mammalian families as the Canidae, the Felidae, the Ursidae, the Equidae, the Cervidae, and the Sciuridae.

The situation among the angiosperms is quite otherwise. Rare indeed is the layman who knows the difference between monocots and dicots, and rarer still one who recognizes any dicotyledonous orders beyond perhaps the legumes and the Cactales, and the Cactales would have to be defined to include a lot of spiny African euphorbiads. The monocots may fare just a little better: The orders Graminales, Liliales, and Palmales, and the more showy members of the family Orchidaceae might well be recognized by many laymen.

[1] Part of an address given at the Third Annual Symposium on Systematics held at the Missouri Botanical Garden on October 27, 1956.

I believe that this difference in the ease with which the major groups of land vertebrates and the major groups of angiosperms can be recognized is no accident, and also no indication of the relative ability of plant and animal taxonomists. The major groups of land vertebrates tend to fill different ecological niches. They differ in the kind of food that they eat and the way that they get it, and their internal and external structure reflects these differences. Once the angiospermous condition has been achieved, on the other hand, the further Darwinian changes which can take place mostly occur so easily and so frequently that they tend to mark species and genera rather than larger groups. Or, as in the case of some evolutionary changes in xylem structure, the same selective forces operate so consistently throughout the group that the sharing of advanced features provides little indication of relationship. The vast majority of angiosperms make and use essentially the same kinds of foods, using the same raw materials which are obtained in the same way, and they rely on the same source of energy for food synthesis. The families and orders, by and large, are not restricted to well defined or even approximately mutually exclusive ecological niches.

The principal characters left to mark the families and orders of angiosperms are the orthogenetic trends, particularly those affecting the structure of the flowers: Such things as hypogyny, perigyny, and epigyny, apocarpy and syncarpy, axile, parietal, free-central and basal placentation, numerous or few floral parts, polypetaly and sympetaly, etc. We know pretty well what the evolutionary trends in these characters are, and some botanists profess to see survival value in them. I must confess myself unable to see the survival value of parietal or free-central placentation over axile placentation, or perigyny over hypogyny, or of epigyny over both perigyny and hypogyny, or of sympetaly over polypetaly, or of definite whorls of stamens over an indefinite spiral, or of one whorl of stamens over two, etc. These differences are in my opinion the result of mere orthogenetic trends, and characters of this sort are nearly all that we have to distinguish most families and orders of angiosperms. The thorough-going structural differences which mark the higher taxa of vertebrates have no real parallel among the higher taxa of angiosperms. Differences in growth habit, which might perhaps be roughly compared to the evident differences among the higher taxa of vertebrates, occur repeatedly *within* the higher taxa of angiosperms, and at best are useful chiefly in combination with more technical characters of flowers and fruit.

The genera and species of angiosperms frequently *do* have a characteristic aspect, and the differences between them often reflect adaptations to particular ecological factors or niches, such as habitat, method of pollination, method of seed dispersal, and the like. Many of these taxa are readily recognizable to the layman. Oak, maple, hickory, goldenrod, ragweed, primrose, nettle, elm, tulip, Norway maple, sugar maple, silver maple, and black maple are all names which mean about the same thing to a great many laymen as to botanists, and the list of commonly recognized genera and species could be extended to some length. Few systematists would deny that related genera and species also sometimes differ chiefly in technical characters which are obscure to the layman and have no very obvious ecological or Darwinian significance. These differences are probably often of orthogenetic rather than Darwinian origin. I have discussed a possible genetic mechanism of orthogenesis in an earlier paper. (Res. Stud. State Coll. Wash. 19: 1-18, 1951).

In conclusion, I make the following suggestions: Both Darwinian and orthogenetic evolution are widespread among both plants and animals. In the higher vertebrates, at least, Darwinian evolution is evident at all taxonomic levels, often tending to obscure the orthogenetic evolution. In the angiosperms Darwinian evolution is operative chiefly at and below the generic level, and the higher categories are marked almost entirely by mere orthogenetic trends.

THE SOUTHWESTERN NATURALIST 1 (3): 100—104 JULY, 1956

SUMMER FOODS OF SOME FISH SPECIES IN EAST BAY, TEXAS[1]

GEORGE K. REID
Department of Zoology, Rutgers University, New Brunswick, New Jersey[2]
ANTHONY INGLIS
Fish and Wildlife Service, Fort Crockett, Galveston, Texas
HINTON D. HOESE
Department of Wildlife Management, Texas A&M College, College Station

ABSTRACT. Stomach contents are reported for 83 croaker *(Micropogon undulatus)* and 280 sand trout *(Cynoscion arenarius)*; also for a few individuals each of sheepshead *(Archosargus oviceps)*, sand perch *Bairdiella chrysura)*, gafftopsail catfish *(Bagre marinus)*, spadefish *(Chaetodipterus faber)*, flounder *(Paralichthys lethostigma)*, and redfish *(Sciaenops ocellata)*. Variety is characteristic in the diets of all species. Populations of these fishes depend upon an adequate supply of small fishes, shrimps, and mollusks.

During the summers of 1954 and 1955, the senior author was engaged in biological studies of East Bay, Texas, as a project of the Marine Division of the Texas Game and Fish Commission. During the investigations the food and feeding habits of several fishes were given attention. The junior authors participated in a program during the summer of 1955, and did intensive work in stomach analyses. Reid (1955a, 1955b) has presented general data on the food of sume East Bay fishes during the summer of 1954. The present paper presents a more salient account of the food relationships of certain of the fishes, and considers the effects on feeding habits of the introduction of more saline water (resulting from the construction of a pass between the bay and Gulf of Mexico, as described below) into the originally estuarine habitat.

East Bay is a northeastwardly oriented arm of the Galveston Bay system, although an extensive reef (Hanna Reef) located across the lower end of the bay serves rather effectively as a barrier between East Bay and Galveston Bay proper. East Bay, approximately 20 miles long and five miles wide at the lower end, is separated from the Gulf by a slender projection of land, Bolivar Peninsula. The maximum depth at mean tide is about seven feet. The upper (northeast) portion of the bay is now connected with the Gulf by a pass (Rollover Pass) approximately 1900 feet long and 80 feet wide, opened in January, 1955.

[1]Contribution from the Marine Laboratory, Texas Game and Fish Commission, Rockport.
[2]Formerly Department of Wildlife Management, Texas A&M College, College Station.

As a result of the exchange of Gulf and bay waters through Rollover Pass, the salinity of the water in the bay during June, 1955, ranged from near 20‰ in the upper portion to approximately 14‰ in the vicinity of Hanna Reef. The average water surface temperature during the day was near 29.0° C. During the period of study the water was highly turbid (Secchi disk determinations averaged approximately 50 centimeters). The bay bottom is mostly mud and is devoid of submerged vegetation. Reid (1955a, 1956) has more fully described the general area, hydrography, fauna, and effects resulting from the introduction of Gulf waters into the bay.

Specimens of fishes were collected by trawling and seining. Stomach contents of larger individuals were examined in the field; analyses of contents of smaller individuals were made in the laboratory. Standard Length is used throughout, this measure being the distance from the anterior end of the fish to the structural base of the caudal fin.

Gratitude is expressed to Mr. Cecil Reid, Director, Marine Division, Texas Game and Fish Commission, for his interest and cooperation in the East Bay project.

MICROPOGON UNDULATUS (Linnaeus). The croaker (family Sciaenidae) is one of the most abundant fishes in East Bay during the summer (Reid, 1955a, 1955b, 1956). Although collecting data indicated a considerably diminished population density for the species from 1955 to 1956, or following the construction of Rollover Pass (Reid, 1956), the existing numbers raised the question of food supply.

Comparison of the present diet data with those of 1954, prior to the introduction of Gulf water into the bay (Reid, 1955b), reveals an increase in the frequency of occurrence of mollusks from 44.7 per cent during the earlier study to 97.5 percent during 1955. Conversely, shrimps occurred in 12.8 per cent of the stomachs examined in 1954, as compared to 6.8 per cent in 1955. It has been shown (Reid, 1956) that the catch of shrimps by collecting year decreased from 1954 to 1955. Although it might not be specious to reason that the decrease in shrimp catch was due entirely to increased salinity in the bay, the increased frequency of occurrence of mollusks might well be correlated with decreased availability of shrimps to feeding croaker.

Stomachs of 83 croaker were examined. The fish ranged from 108 to 227 mm. in length, with most of the specimens 164 to 198 mm. Of 73 stomachs which contained food, the pelecypod, *Macoma mitchelli*, occured in 76.7 per cent. Fish remains were found in 8.2 per cent of the stomachs, the only identifiable form being a species of anchovy, probably *Anchoa mitchelli diaphana*, which was abundant in the bay.

Shrimps were eaten by 6.8 per cent, and crabs by 6.8 per cent of the croaker. Annelids occurred in 4.1 per cent of the stomachs. Ten, or 13.7 per cent, of the fish contained plant debris and unrecognizable organic detritus. In view of the frequency and amount of debris present in the stomachs, it is suggested that the material may serve as an energy source.

Pearson (1929, 203) in his study of sciaenids of Texas reported that of 60 croaker, 21-35 cm. total length, 55 per cent had eaten shrimps; 13 per cent, annelids; 12 per cent, fishes; 5 per cent, crabs; and 5 per cent had ingested mollusks. Smaller fish (19 specimens), 14 to 20 cm. in length, had eaten mainly annelids. Since most of Pearson's specimens were taken from passes between bays and the Gulf (*op. cit.*, 197), the nature of the diet of bay inhabitants is not fully indicated. The data do have considerable value in relating to possible transitions in diet as the fish move into and from the bays and in reflecting the food utilized in the Gulf and Gulf-influenced areas.

CYNOSCION ARENARIUS Ginsburg. Sand trout (family Sciaenidae) were common in East Bay during both summers. The catch per unit of effort was less in 1955 than in 1954, however (Reid, 1956). Individuals caught by the various gear generally ranged in size from 20 to 115 mm., although larger trout were frequently caught by sport methods. Food studies of this species were especially fruitful in revealing the roles of three major groups of organisms in the diet of growing trout.

Table 1 clearly demonstrates the increasing utilization of fishes as larger size is attained by trout. Menhaden, *Brevoortia patronus*, were eaten by eight of fifteen trout larger than 100 mm., while only two fishes smaller than 100 mm. had taken menhaden. The fish diet of trout of intermediate sizes consisted of anchovy and, indicating cannibalism, small sand trout.

At the lower limit of the size range, plankton-sized organisms, comprising larval and metamorphosing shrimps and crabs, copepods, and others, occurred with greatest frequency in trout from 20 to 59 mm. in length. Our data failed to show plankton taken even incidentally by trout larger than 79 mm. As indicated in Table 1, the frequency of occurrence of plankters in trout stomachs varied inversely as the size of the fish.

The role of young shrimps which were common during the season of abundance of small trout appears to be that of a "sustainer" during the change-over from plankton to fishes. Table 1 indicates that shrimps were taken with greatest frequency by trouts of the 60 to 79 mm. size range.

Size Class (mm.)	20-39		40-59		60-79		80-99		100-119		Totals	
No. of Stomachs Examined	61		129		42		16		28		280	
No. of Stomachs Containing Food Items	59		118		31		10		15		233	
Items	No. of Stomachs	%	No.	%	No.	%	No.	%	No.	%	No.	%
Fishes	4	6.8	38	32.2	25	80.6	8	80.0	14	93.3	89	38.2
Shrimps	4	6.8	35	29.6	20	64.5	4	40.0	4	26.6	67	28.7
All Non-Plankton Items	6	10.1	60	50.8	30	96.7	10	100.0	15	100.0	111	47.6
Plankton-sized Items	57	96.6	83	70.3	8	25.8	0	0	0	0	148	63.5
Miscellaneous (sand, organic debris, etc.)	1	1.7	2	1.7	1	3.2	3	30.0	0	0	7	3.0

Although somewhat general in nature, brief studies of the food of additional fish species in East Bay pointed to the considerable variety of items taken as food, as well as the importance of sustained populations of forage organisms. Four examples of sheepshead, *Archosargus oviceps* (family Sparidae), 230 to 400 mm. in length, had consumed crabs, pelecypods, and vegetable matter. Four sand perch, *Bairdiella chrysura,* family Sciaenidae), 113 to 155 mm. in length, took shrimps and fishes for food. Stomachs of four gafftopsail catfish, *Bagre marinus* (family Ariidae), 235-298 mm. in length, contained organic debris, crabs, and fishes (worm eel, *Myrophis punctatus,* and menhaden). Ten specimens of the spadefish, *Chaetodipterus faber* (family Ephippidae), 64 to 124 mm. in length, had eaten fishes, mol-

lusks (mostly pelecypods), vegetation, and organic debris. Four flounder, *Paralichthys lethostigma* (family Bothidae), subsisted largely on fishes and shrimps. Six specimens of redfish, *Sciaenops ocellata* (family Sciaenidae), 400 to 433 mm. in length, consumed shrimps and a considerable mass of fishes (one specimen contained 23 menhaden; another, three mullet, two killifish, two menhaden, and one pinfish).

It is apparent that the maintenance of the population of larger individuals of a fair number of species is largely dependent upon an adequate supply of small fishes, shrimps, and mollusks. Young fishes, small plankton-feeding fish species, and shrimps are dependent upon basic productivity within the bay to supply organic material and plankton. The abundance of small shrimps, fishes such as anchovy and menhaden, and the actual extent of bottom detritus attest to the fecundity of the bay as a community.

LITERATURE CITED

PEARSON, JOHN C. 1929. Natural history and conservation of the redfish and other commercial sciaenids on the Texas coast. *Bull. Bur. Fish.* 44: 129-214.

REID, GEORGE K., Jr. 1955a. A summer study of the biology and ecology of East Bay, Texas, Part I. *Tex. Jour. Sci.*, 12 (3): 316-243.

——1955b. A summer study of the biology and ecology of East Bay, Texas, Part II. *Tex. Jour. Sci.* 12 (4): 430-453.

——.1956. Ecological investigations of a disturbed Texas coastal estuary. *Tex. Jour. Sci.* 8: 296-327.

THE SOUTHWESTERN NATURALIST 1 (3): 105—108 JULY, 1956

DIMORPHISM AND CANNIBALISM IN TADPOLES OF SCAPHIOPUS BOMBIFRONS (AMPHIBIA, SALIENTIA)

ARTHUR N. BRAGG

Department of Zoology and Biological Survey, University of Oklahoma, Norman

ABSTRACT. A tadpole of *Scaphiopus bombifrons* was seen to kill and eat eight others of its kind (in Tillman Co., Oklahoma). No others in several cultures were predaceously cannibalistic and predation could not be induced by feeding dead tadpoles to hungry individuals. Eight out of several hundreds preserved as collected at the same time and place had a buccal apparatus like that of the cannibal and were presumably cannibalistic in nature.

Predaceous and cannibalistic tendencies have long been known in the tadpoles of the spadefoot toads (*Scaphiopus*), especially those of the so-called *hammondi* group (subgenus *Spea*). Recently another wholly unexpected phenomenon has come to light, namely dimorphism within single species. The first to show that this might be the case was, apparently, Stebbins (1951), who questioned the mouth-part characters utilized by Smith (1934) and Bragg (1941) in their attempted taxonomic distinction between larvae of *Scaphiopus bombifrons* Cope and *S. hammondi hammondi* Baird. The next year, Turner (1952) reported tadpoles of intermediate mouth-parts from widely separated populations and concluded that the mouth-part characters in question could not clearly define these tadpoles. Similar intermediate tadpoles have long been known in Western (but not Central) Oklahoma but they had been interpreted as hybrids (Bragg, 1946, and especially, 1948).

Orton (1954) reviewed the more important literature on this problem and added the first specific record of a single tadpole which, on distributional grounds, had to be of *S. bombifrons* but which showed the beaked condition of the upper jaw and over-developed jaw-muscles supposed by Bragg (1941) to be diagnostic of *S. h. hammondi*. This evidence when added to that of Stebbins and Turner opens up the whole question again as to what (if anything) will distinguish among tadpoles in the subgenus *Spea* (especially those of *S. bombifrons* and *S. hammondi*) as well as the question of the relationship of dimorphism and cannibalism.

It should be noted that, so far as I can find out, no one has yet certainly *seen* an undoubted tadpole of *S. bombifrons* attack, kill, and

eat another of its species. Gilmore (1924) and Smith (1934) may still have had *S. hammondi* or a mixture of the two species involved. It is now presumable that I saw this in cannibalistic aggregations (Bragg, 1946) as I thought at that time, having been led astray later in interpretation by finding supposed *S. h. hammondi* among them (Bragg, 1948). But, since the strongly beaked type with hypertrophied jaw muscles has been proved to be characteristically cannibalistic and since this type is now known to occur within some populations of *S. bombifrons* (Bragg, 1946, 1948; Orton, 1954) there is a strong presumption that some populations of *S. bombifrons* produce two types of tadpoles, one cannibalistic and the other not, as emphasized by Orton and presumably seen but misinterpreted by me (Bragg, 1948).

The present paper reports a clear-cut case of dimorphism in tadpoles of *Scaphiopus bombifrons* associated with predaceous cannibalism of at least one tadpole and probably other individuals from a single breeding site. The details are as follows.

On May 12, 1956, a shallow, semi-turbid ditch beside Oklahoma Highway 5, one mile west of Tipton, Tillman County, Oklahoma was swarming with tadpoles of *Scaphiopus bombifrons* about midway in their development. While I was watching their behavior, a single tadpole about twice the size of the others and with very strongly developed jaw muscles was seen. Since there had been only one rain here sufficient to stimulate breeding, this larva, despite its size, must have been of the same age as the others. A large collection was made by blind sweeping through the waters, some tadpoles being retained alive, the remainder preserved in formalin as collected.

Two days later, May 14, at 2:15 p.m., I set up experiments intending to determine the growth rates of the former group under different conditions of food supply. Ten tadpoles, meant as a control, were fed on boiled lettuce upon which the larvae all fed normally at a pH of 7.0± to 8.0± and at temperatures of 23° to 26° C. Approximately two hours after the culture was started (at 4:37 p.m.) the largest tadpole here was found with a smaller one in its mouth. During subsequent days this tadpole was *seen* to attack seven other tadpoles and to eat all or part of each one in turn, approximately one each day. It often killed and partly devoured an individual, then left it; sometimes it returned to feed again but more often it killed another while the remains of the first were still present. Between such cannibalistic meals, it ate the lettuce. Other tadpoles both in this culture and in others, fed upon dead tadpoles, as available, or upon the lettuce; but

out of several hundreds being watched this was the only individual seen to attack another, kill, and then feed upon it.

In another culture, some sun-dried tadpoles of *S. bombifrons*, collected from a terrace ditch where they had died as the water disappeared, were used as the only food supply. This food was acceptable to these individuals but they grew at a slower rate than those on lettuce, perhaps partly because of bacterial action in the more concentrated organic matter. After several changes of water to reduce this action and after all food was gone, I kept these animals in tapwater for several hours more to insure their need of food. I then placed a few live tadpoles from a second lettuce culture with them, selecting slightly smaller individuals for purposes of identification. The object was to determine whether cannibalism would develop among them, since they were now conditioned to dead tadpoles as food. The result was negative.

Since the single cannibal in the first culture had also had lettuce available, I then added boiled lettuce to this second culture in about the same amount as used in the first. The result was still negative. All tadpoles ate the lettuce avidly but none showed any predatory tendencies.

I then examined the preserved tadpoles already mentioned. Several hundreds were spread out in a white pan in 65% alcohol beneath a strong light. Seven of the lot were clearly different in coloration and in body proportions from the others and an eighth seemed intermediate. All eight of these showed various degrees of stronger development of the jaw muscles than the others and, perhaps more important, every one had some development of the beak-notch relationship in their jaws formerly supposed characteristic of *S. h. hammondi* (Smith, 1924; Bragg, 1941), and two were of the extreme type essentially as figured by Smith (1934) and emphasized by Orton (1954). Since no others in a large random sampling of the other tadpoles showed this condition, and since the single proved cannibal also had this type of jaw, the conclusion seems inescapable that, as Turner (1952) and Orton (1954) have emphasized, *S. bombifrons* has two types of tadpoles morphologically and behavioristically different from each other. Furthermore, one can clearly see the probable effect here of a genetic difference. These conclusions being true, it follows that no description of the tadpole of *S. h. hammondi* yet given is adequate.

The one possible escape from these conclusions could be that just possibly tadpoles of both species were originally present. But this is quite unlikely for the following reasons. (1) *S. h. hammondi* has never

been seen or heard in Tillman County, Oklahoma during many observations, during the breeding of *S. bombifrons* and *S. couchi* there. (2) Many tadpoles of the living ones of this lot (including the cannibalistic individual) passed metamorphosis successfully and were reared to about one-fourth adult size. All were clearly *S. bombifrons* as judged by adult and juvenile characters.

LITERATURE CITED

BRAGG, ARTHUR N. 1941. Tadpoles of *Scaphiopus bombifrons* and *Scaphiopus hammondi*. Wasmann Collector 4 (3): 72-74.

..... 1946. Aggregation with cannibalism in tadpoles of *Scaphiopus bombifrons* with some general remarks on the probable evolutionary significance of such phenomena. Herpetologica 3: 89-96.

..... 1948. Additional instances of social aggregation in tadpoles. Wasmann Collector 7: 65-79.

GILMORE, R. J. 1924. Notes on the life history and feeding habits of the spadefoot toad of the western plains. Colorado Coll. Publ. Sci. Ser. 13 (1): 1-12.

ORTON, GRACE L. 1954. Dimorphism in larval mouth-parts in spadefoot toads of the *Scaphiopus hammondi* group. Copeia 1954 (2): 97-100.

SMITH, HOBART M. 1934. The amphibians of Kansas. Amer. Midl. Nat. 15 (4): 377-525.

STEBBINS, ROBERT C. 1951. Amphibians of Western North America. University of California Press. ix, 539 pp.

TURNER, FREDERICK B. 1952. The mouth parts of tadpoles of the spadefoot toad, *Scaphiopus hammondi*. Copeia 1952. (3): 172-175.

THE SOUTHWESTERN NATURALIST 1 (3): 109—115 JULY, 1956

FOSSIL RABBITS (LAGOMORPHA) OF THE FRIESENHAHN CAVE DEPOSIT, TEXAS

DAVID PETTUS

Department of Zoology, Colorado A&M College, Fort Collins

ABSTRACT. Three species of rabbits are identified among fossil specimens from Friesenhahn Cave, Bexar Co. (late Pleistocene deposits): *Sylvilagus floridanus* (J. A. Allen), *S. auduboni* (Baird), and *Lepus californicus* Gray. The fossil *S. floridanus* are compared with Recent examples of the same species. In three of four lower-jaw characters the fossil rabbits proved to be significantly larger than representatives of the same species now occurring in the area.

Much of our knowledge of North American Pleistocene vertebrate faunas is derived from the study of various cave deposits. The Friesenhahn Cave, in Bexar County, Texas, has proved to be a rich source of these materials. Fossils referable to the genus *Perognathus* from this site have been studied by Kennerly (1956). Milstead (1956) investigated the fossil turtles from this deposit. Both of these authors describe the physical features of the cave.

Parelephas, Dinobastis, Mammut americana, Aenocyon, Bison and numerous smaller forms have been found in abundance at this site. From our present knowledge of the fauna this deposit should be referred to one or more stages of the Wisconsin of the late Pleistocene period.

Hay (1921) referred several fragments collected at this site to the genus *Sylvilagus*, but did not designate the species. Until the present, no subsequent attempts have been made to establish the identity of these rabbits.

Based upon comparisons with recent forms, three species of lagomorphs taken from this deposit are distinguishable among specimens in the Texas Memorial Museum Collection. They are *Lepus californicus, Sylvilagus floridanus,* and *S. auduboni.*

METHODS AND MATERIALS

All of the lagomorph fossils were obtained from zones three and four (see either Kennerly, 1956; or Milstead, 1956). Follansbee's (unpublished) work on the pocket gophers and other evidence suggests very strongly that zone four is comprised of re-worked materials from

zone three, hence there is no good reason for separating the fossils in these two zones. No such separation was made in the present investigation.

The great majority of the lagomorph fossils are mandibular fragments, but several maxillae, post-cranial elements, and one incomplete skull are available. Only the mandibular material was studied intensively. Fifty-six lower jaw fragments are definitely referable to *S. floridanus* (J. A. Allen). Five mandibular remnants may be assigned, with reasonable certainty, to *S. auduboni* (Baird), a species which no longer occurs in the area. Three specimens of *Lepus californicus* Gray are represented by mandibular fragments. It was impossible to identify four other lower jaws, either because of their immaturity or their fragmental condition. The remaining cranial elements compare well with *S. floridanus* and are assigned to this species. The post-cranial remains were not studied.

Identification of the mandibulae was based upon a combination of three characters: (1) shape and enamel pattern of the third premolar, (2) the posterior termination of the mental symphysis, and (3) size. In *S. floridanus* the posterior and lingual borders of the third lower pre-molar meet at more of a right angle than in *S. auduboni* where these two surfaces curve more gradually into one another. The two species of *Sylvilagus* may also be differentiated from one another in most cases by the relationship of the most posterior extension of the mental symphysis and the anterior border of the third lower premolar. The symphysis typically extends as far posteriorly, or exceeds the anterior face of this tooth in *S. floridanus*, but fails to do so in *S. auduboni*. The jaws of mature individuals of the two species of *Sylvilagus* are most readily distinguished from those of mature *Lepus* on the basis of size, but in questionable cases one may rely with a reasonable degree of certainty upon the enamel patterns of the third lower pre-molar to separate the two. The posteriorly directed cape on the anterior border of the re-entrant fold in *Lepus* is typically more pronounced than in either of the cottontails. The use of any one of these characters without reference to the others might lead to confusion, but in combination they have been a usable means of diagnosis.

The number of *S. floridanus* mandibles available made possible a statistical comparison of the fossil and recent populations. Series of other bones, of both *S. floridanus* and the other two species, were so small that no quantitative treatment of them was attempted.

Four characters in the lower jaw were chosen for study. They are: (1) length of the molar tooth row, (2) diastema length, (3) anterior jaw height, and (4) posterior jaw height. The first, length of the molar tooth row, was measured from the anterior face of the third pre-molar to the posterior edge of the alveolus of the last molar. In specimens in which PM_3 was absent the measurement was made from the anterior edge of the alveolus. Diastema length was measured from the anterior face (or edge of the alveolus) of PM_3 to the most anterior projection of the ramus superior to the incisor. Anterior jaw height was measured as the maximum vertical dimension of the ramus anterior of the sheath of bone encircling the third pre-molar. The posterior height of the jaw as used here is the vertical dimension of the ramus measured at the fourth molar. All measurements were made with Vernier calipers reading at 0.1 millimeter.

The Friesenhahn cave is situated within the range of the Recent subspecies *S. f. chapmani* (Hall, 1951). Only specimens of this race were used for comparison with the fossil *S. floridanus*. The Recent material is in the Texas Natural History Collection, University of Texas; the Wildlife Cooperative Unit Collection at Texas Agricultural and Mechanical College; and in the author's personal collection. The fossils are in the collection of the Texas Memorial Museum.

A resume of the statistical results is presented in Table I. A graphic representation, based on the method of Hubbs and Hubbs (1953) is shown in Figure I. The base line indicates the extremes of variation, the vertical line represents the mean. One standard deviation on either side of the mean is shown by the open triangles, while twice the standard error on each side of the mean is indicated by the solid rectangles.

When two samples are compared by this method, a very significant difference is shown to exist between them when the values for 2_{σ_m} on either side of the mean of each sample fail to overlap. Such is the case for three of the four characters analyzed. In these three characters; length of molar tooth row, anterior jaw height, and posterior jaw height, the fossil *S. floridanus* are shown to be significantly larger than the Recent population now inhabiting the area around the cave. While no significant difference is demonstrated in the fourth character, diastema length the mean of the fossil sample is greater than that of the Recent material.

Discussion

Since the jaws of the fossil rabbits were larger than Recent examples it is possible that the body size was greater also. It is possible that

allometric changes have taken place which would preclude this, but the assumption that the rabbits, represented by their jaws in this cave deposit, were larger "overall" than the *S. floridanus* now in the area is the simplest. This assumption appears even more likely when we take into account that the characters in which the greatest differences were found are closely associated with the food grinding apparatus. A larger rabbit should reasonably be expected to require more food and hence, an enlarged molar area for grinding it.

The reasons why the Pleistocene *S. floridanus* were larger than their present relatives in the area are not immediately obvious. Classically it might be assumed that the climate during the time of deposition of the fossils was cooler than at present and that the rabbit population was responding in accord with Bergmann's Rule (1847). However there is evidence to indicate that such is not the case. In the first place, if this rule can be accepted, we should expect to find modern *S. floridanus* in more northerly latitudes to be larger than their more southern relatives. According to Nelson (1909), the largest members of this species occur near the southern limits of its range. They are the subspecies *S. f. chiapensis* and *S. f. yucatanicus* of southern Mexico.

Another disparity is shown by the fossil reptiles from the Friesenhahn deposits. A complementary assumption to Bergmann's rule is that heterothermal tetrapods are smaller with increasingly colder climates (Allee *et al.*, 1949). The amphibians and reptiles of this cave deposit have been studied by Dr. John S. Mechem (personal communication) and he reports that they are no smaller and, perhaps, even somewhat larger than the modern representatives of the same species.

Another line of evidence tending to contradict the action of Bergmann's rule is found in a recent paper by Scholander (1955). He states, "there is no physiological evidence, in beast or man, that the minor and erratic subspecific trends expressed in Bergmann's and Allen's rules reflect phylogenetic pathways of heat-conserving adaptation."

Thus is would appear unjustified to assume that the rabbits represented by the fossils lived during a time of cooler climate. No reasonable explanation is offered at this time for the difference in size in the two samples of cottontails, but one interesting correlation is suggested. Possibly the same factor or factors which operated to cause the extinction of many of the large Pleistocene mammals acted upon the rabbits also to selectively produce smaller body size.

TABLE I

STATISTICAL SUMMARY OF DIFFERENCES BETWEEN FOSSIL AND RECENT *SYLVILAGUS FLORIDANUS* *

	Length of Molar Tooth Row	Diastema	Anterior Jaw Height	Posterior Jaw Height
Fossil *S. floridanus*				
Sample size	39	27	48	37
Range	11.6-14.6	13.6-18.0	7.2-9.2	11.6-14.8
Mean	13.6	15.5	8.2	13.3
Standard Deviation	0.59	1.11	0.5	0.70
Standard Error	0.095	0.22	0.7	0.16
2 Standard Errors	0.19	0.44	1.4	0.32
Recent *S. floridanus*				
Sample size	22	21	21	21
Range	11.8-14.3	13.2-17.6	6.6-8.3	10.4-13.1
Mean	13.0	15.2	7.5	12.0
Standard Deviation	0.70	1.12	0.5	0.71
Standard Error	0.15	0.25	0.12	0.16
2 Standard Errors	0.30	0.50	0.24	0.32

* All measurements in millimeters.

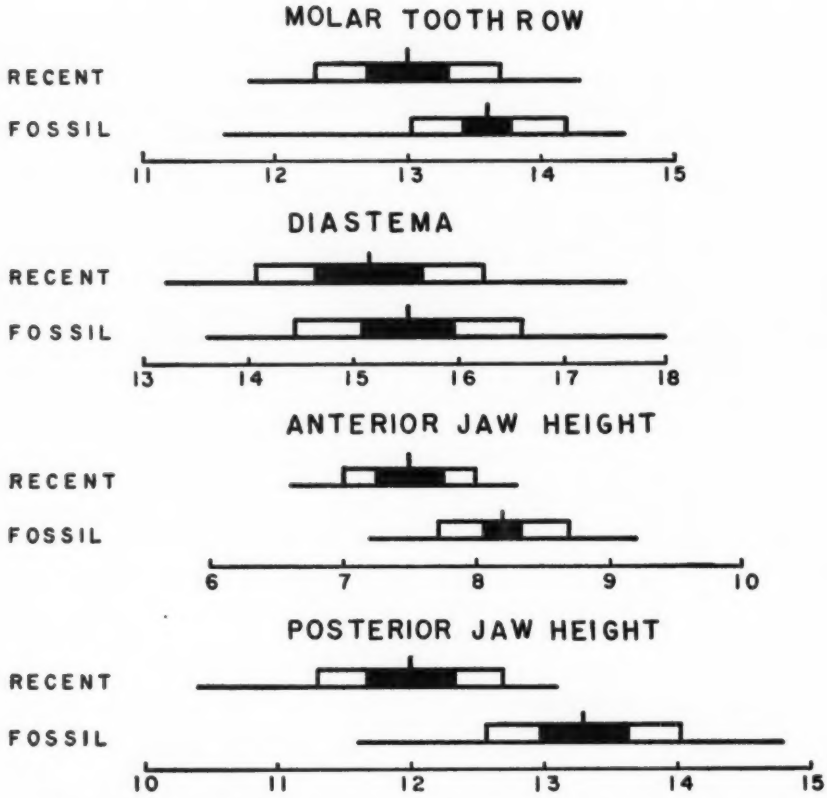


Fig. 1. Comparison of four mandibular characters of fossil and Recent **Sylvilagus floridanus.** (See text p. 111 for explanation.)

Summary

Three species of rabbits are identified from the Friesenhahn Cave deposits. They are *Lepus californicus, Sylvilagus auduboni* and *S. floridanus,* all three of which are living forms. They are represented by various post cranial elements, one incomplete skull, several maxillary fragments and a large series of mandibles. Most of the mandibles are those of *S. floridanus.* The large series of these available permitted a quantitative comparison of fossil and living forms. In three of the four characters analyzed the fossils proved to be significantly larger than the modern form. A discussion of the reasons for this size difference is included, but no tenable explanation can be offered at present.

Acknowledgments

The author wishes to express his gratitude to Dr. William B. Davis, of Texas Agricultural and Mechanical College, for allowing him to examine specimens in the Texas Cooperative Wildlife Unit Collection at that institution; to Dr. W. Frank Blair, of the University of Texas, for his assistance; and to Dr. John A. Wilson, of the University of Texas, for his advice and direction in the course of the research.

LITERATURE CITED

ALLEE, W. C., et al. 1949. Principles of Animal Ecology. W. B. Saunders & Co., Philadelphia and London. xii, 837 pp.

BERGMANN, C. 1847. Ueber die Verhältnisse der Wärmeökologie der Thiere zu ihrer Grösse. Götting. Stud. 1: 595-708.

HALL, E. RAYMOND. 1951. A synopsis of the North American Lagomorpha. Univ. Kans. Publ., Mus. Nat. Hist. 5 (10): 119-202.

HAY, O. P. 1921. Descriptions of some Pleistocene vertebrates found in the United States. Proc. U. S. Nat. Mus. 58: 83-146.

HUBBS, CARL L., and CLARK HUBBS. 1953. An improved graphical analysis and comparison of series of samples. Syst. Zool. 2 (2): 49-57.

KENNERLY, THOMAS E., Jr. 1956. Comparisons between fossil and Recent species of the genus *Perognathus*. Texas J. Sci. 8 (1): 74-86.

MILSTEAD, WILLIAM W. 1956. Fossil turtles of Friesenhahn Cave, Texas, with the description of a new species of *Testudo*. Copeia 1956 (3): 162-171.

NELSON, E. W. 1909. The Rabbits of North America. N. Amer. Fauna 29.

SCHOLANDER, P. F. 1955. Evolution of climatic adaptation in homeotherms. Evolution 9 (1): 15-26.

THE SOUTHWESTERN NATURALIST 1 (3): 116—120 JULY, 1956

BRYOPHYTES FROM GUADALUPE ISLAND, BAJA CALIFORNIA

HOWARD CRUM
National Museum of Canada, Ottawa
HARVEY A. MILLER
Miami University, Oxford, Ohio

ABSTRACT. Previously only 16 mosses and 8 hepatics were known from Guadalupe Island. During its Spring 1955 cruise the "Orca" touched at the Northeast Anchorage where the junior author collected between 2800 and 3800 ft. alt. during two days. Fifteen mosses (including 1 species previously collected by A. W. Anthony) and 3 liverworts are listed. Ten of the mosses are new to the island, and 3 (*Tortula ruralis, Grimmia trichophylla* var. *brachycarpa, Orthotrichum bolanderi*) are new to Mexico.

It is not surprising that only a few collections of bryophytes have been made in Baja California, either on the mainland or on the offshore islands, because of the extremely dry climate which forbids an obvious growth of mosses, as well as the destruction of many suitable habitats by the activities of man and his animals. Recently Koch and Crum (1950) presented a list of all the mosses known from the political confines of Baja California and showed that, although only 47 species had thus far been found, the moss flora of the northern half of the peninsula and of Cedros and Guadalupe Islands is distinctly Californian, whereas the mosses of southern Baja California belong to the Mexican highland flora. Recent collections, including 23 mosses from Cedros collected by William C. Steere during the 1952 cruise of the "Orca" (as yet unpublished) and 14 species from Guadalupe collected on the 1955 cruise by the junior author, serve also to emphasize the Californian affinities in the islands.

Guadalupe Island lies in the Pacific Ocean 180 miles off the coast of central Baja California. It is 80 square miles in area and boasts considerable relief, with an extinct volcano reaching an altitude of about 4500 feet. In 1923 the Mexican government set aside the island as a game preserve, especially intended for the protection of elephant seals. More recently the Guadalupe fur seal once believed to be extinct has been rediscovered. The 1955 expedition, under the direction of Professor Carl Hubbs of the Scripps Institution of Oceanography, was organized for the purpose of relocating and studying these rare seals which had been sighted on a previous trip. In the course of the search the "Orca" circumnavigated the island and a number of landings were

accomplished. The personnel of the expedition included the owner of the "Orca," Mr. Joseph Sefton, Jr.; Professor Hubbs, his wife Laura and their assistant, Dr. Victor B. Scheffer of the U.S. Fish and Wildlife Service; Dr. George Lindsay, Director of the San Diego Natural History Museum; Job Kuijt, a graduate botany student at the University of California; Harvey A. Miller, then a graduate student in botany at Stanford University; and the three man crew.

June 10 the ship anchored in the Northeast Anchorage, and Kuijt and Miller began the ascent of the island to remain overnight at the summit and return the next day. Except for a small clump of *Nicotiana glauca* in the mouth of the canyon and a few scattered Guadalupe Palms (*Erythea edulis*) at the top of the fog-shrouded cliffs, no large plants were apparent at the start of the upward trek. The terrain is not steep or treacherous along the vaguely-defined trail to the summit, but it is very difficult underfoot because the ground is covered with loose lava rocks too small to step on without rolling and too numerous to step between. Wild goats, introduced sometime prior to 1875 and now present in almost unbelievable numbers, formed an undulating multihued mosaic on the parched landscape. Only a tiny species of *Erodium* and the bryophytes were ignored by these voracious beasts as they continued their complete and systematic devastation of an island which Dr. Edward Palmer described as a naturalists' paradise in 1875. Mature trees scattered near the summit, stripped as high as goats can reach, were the only woody plants observed except for the small clump of inedible *Nicotiana* at the anchorage. This northeastern part of the island was the only place visited where bryophytes were observed and collected, but time did not allow extended searches for suitable microhabitats. Many lichens observed and collected at the various landings will be reported later by Dr. Henry Imshaug.

The bryophyte flora of Gualalupe is probably larger than our present records indicate since only the relatively dry leeward side and a small portion of the summit have been collected. Exploration of the nearly inaccessible fog-shrouded windward higher elevations should reveal numerous interesting species. Also, heads of the larger canyons, including one at the Northeast Anchorage, probably provide several microhabitats for more mesic species than those known from the island. The introduced *Nicotiana* may provide cover for species of bryophytes now holding on in tiny niches over the island.

Only a few collections from Guadalupe, including small ones made by Edward Palmer, A. W. Anthony and John Thomas Howell, have been recorded. Koch and Crum (1950) reviewed the literature on mosses and listed only 16 species: *Aloina rigida* var. *pilifera*, *Desmato-*

don convolutus, Pottia fosbergii, Tortula muralis, Trichostomum crispulum (?), Weissia controversa, Grimmia laevigata, G. pulvinata, G. trichophylla, Funaria hygrometrica, Bryum argenteum, B. caespiticium, Anacolia menziesii, Dendroalsia abietina, Camptothecium arenarium and *Scleropodium touretii*. Ten species can be added to that list by the collections listed below; of these, *Trichostomopsis fayae, Tortula ruralis, Grimmia trichophylla* var. *brachycarpa, Orthotrichum bolanderi* and *Claopodium whippleanum* var. *leuconeuron* are new to Mexico.

The first list of Hepaticae was compiled by Dorothy Sutliffe (1932) on the basis of Howell's collections of 1931. These collections all came from the same general area visited by the junior author although Howell did visit, in addition, the palm fog belt. Only eight species were listed: *Targionia hypophylla, Asterella palmeri, Riccia sorocarpa, R. trichocarpa, R. mauryana, Lophocolea bidentata, Porella navicularis* and *Frullania catalinae*. The three *Ricciae* were again reported by Howe (1934), who apparently saw the same Howell collections that Sutliffe had examined. The report of *Asterella californica* from Guadalupe given by Frye and Clark (1937) is not to be found in the references cited and appears to be completely erroneous.

With the exception of one specimen collected by Anthony but not previously reported, all the collections were made by the junior author above the Northeast Anchorage, mostly at altitudes between 2800 and 3800 feet on June 10 and 11, 1955. We wish to thank Mr. Joseph Sefton and the Sefton Foundation for generous support of the expedition, Professor Carl Hubbs for allowing the junior author to accompany him to the relatively inaccessible region and for his consideration of the botanists, and Dr. George Lindsay for his helpful cooperation before, during and after the trip.

MUSCI

FISSIDENS LIMBATUS Sull. 5533. This is a common species on the west coast of North America, particularly in California; it has also been collected on Cedros Island and on the southern mainland of Baja California.

TRICHOSTOMOPSIS FAYAE Grout. 5520 and 5521 *p. p.* (with *Desmatodon convolutus*), 5528a. Apparently common in southern California, this species has also been collected on Cedros Island.

DESMATODON CONVOLUTUS (Brid.) Grout. 5506, 5520, 5521, 5529 *p. p.* (with *Tortula brevipes*). Common in southern California and the American Southwest, this species has also been found twice previously on Guadalupe Island and also in the state of Tlaxcala in east-central Mexico.

DESMATODON GUEPINII BSG. 5528. Previously known from southern California, northern Baja California and New Mexico.

TORTULA BREVIPES (Lesq.) Broth. 5529, 5530. Widespread in the West, common in California, and represented at least in northern Baja California and on Cedros Island.

TORTULA RURALIS (Hedw.) Smith. 5509, 5511, 5512, *p. p.* (with *Orthotrichum bolanderi*), 5523. No typical material of this very widely ranging species has yet been found in Mexico, although similar specimens, rather depauperate, have been collected on Cedros Island. *Tortula ruralis* is extremely variable and in its reduction forms often resembles poorly developed *T. obtusissima* (C. M.) Mitt. Since the floras of Guadalupe and Cedros Islands are entirely Californian in character, it seems reasonable to refer these plants to *T. ruralis*, which is common in California, rather than to *T. obtusissima*, which is characteristic of the Mexican highlands but not yet known from Baja California.

GRIMMIA LAEVIGATA Brid. (Brid.) Brid. 5524. This species has already been found on Guadalupe Island and on the mainland in northern Baja California. It is common in central and southern California and widespread throughout the United States.

GRIMMIA MONTANA BSG. 5503, 5510b. Also known from Cedros Island; widespread in the western United States. The previous report by Koch and Crum (1950) from northern Baja California should be referred instead to *G. alpestris* Nees. Dr. Geneva Sayre has confirmed the revision of determination.

GRIMMIA TRICHOPHYLLA Grev. 5505, 5507, 5508, 5517. Previously known from Guadalupe Island and also from Cedros Island. Common in western North America from Alaska to California and eastward to Colorado; known from several parts of Mexico.

GRIMMIA TRICHOPHYLLA var. BRACHYCARPA DeNot. (*G. trichophylla* var. *meridionalis* Schimp.). These plants are robust and loosely tufted, and their leaves are widely spread when moist. In these respects, they conform to unquestionable material of the variety, not previously recorded from outside California. It would seem doubtful, however, whether such differences justify a rank greater than form.

BRYUM ARGENTEUM Hedw. 5520 *p. p.* (with *Desmatodon convolutus*), 5522 *p. p.* (with *Asterella palmeri*), 5527, 5529 *p. p.* (with *Tortula brevipes*), Previously known from southern Baja California and from both Guadalupe and Cedros Islands; cosmopolitan and weedy.

ANACOLIA MENZIESII (Turn.) Par. 5510a, 5526. Previously known from Alaska to California and Guadalupe and Cedros Islands.

ORTHOTRICHUM BOLANDERI Sull. 5512. This is the first record of this interesting species outside the limits of California. The plants were fruiting sparsely, but even when sterile the species is quite distinctive in having bistratose leaves.

ORTHOTRICHUM LYELLII Hook. & Tayl. 5502, 5511a. These plants could be referred to the variety *papillosum* (Hampe) Lesq. & James, but is seems very unlikely that the absence of propagula can be of genetic significance in a genus notable for the production of propagula, occasionally or even frequently. Widespread in western North America and already known for a few collections from Cedros Islands.

CLAOPODIUM WHIPPLEANUM var. LEUCONEURON (Sull. & Lesq.) Grout. Guadalupe Island, without location, *A. W. Anthony*, 5 July—October, 1896. A poorly delimited form of the species, ranging from Washington to California.

HEPATICAE

CALYPOGEIA TRICHOMANIS (L.)Corda. 5531 *p. p.* (with *Asterella palmeri*). Previously reported from Hacienda de Mirador (Veracruz) by Gottsche (1867), this species is widely distributed in Europe and North America.

TARGIONIA HYPOPHYLLA L. 5514, 5515, 5518, 5519 *p. p.* (with *Asterella palmeri*), 5525 *p. p.* (with *A. palmeri*), 5532 *p. p.* (with *A. palmeri*). Common in California, Mexico and the western United States, this plant is also known from Europe, Asia, Africa, Hawaii and several South Pacific Islands.

ASTERELLA PALMERI (Aust.) Underw. 5504, 5511, 5522, 5525, 5531, 5532. This species is locally abundant on the south face of the canyon at the Northeast Anchorage where it was probably first collected by Edward Palmer. It has since been discovered in California and New Mexico. In the field it is often mixed with mosses and other hepatics.

LITERATURE CITED

FRYE, T. C., and LOIS CLARK. 1937. Hepaticae of North America. Univ. Washington Publ. Biol. 6 (1): 1-162.

GOTTSCHE, C. M. 1867. De mexikanske Levermosser. Kongl. Danske Vidensk. Selsk. Skrifter, 5. Raecke, Naturv. Math. Afd. 6: 97-382.

HOWE, M. A. 1934. The Hepaticae (chiefly *Riccia* and *Anthocerotaceae*) of the Galapagos Islands and the coast and islands of Central America and Mexico. Proc. Calif. Acad. Sci. 21 (17): 199-210.

KOCH, L. F., and H. A. CRUM. 1950. Mosses of Baja California. Rev. Bryol. et Lichenol. 19 (3/4): 188-192.

SUTLIFFE, DOROTHY. 1932. Hepaticae of Guadalupe Island. The Bryologist 35 (3): 41-42.

THE SOUTHWESTERN NATURALIST 1 (3): 121—124 JULY, 1956

PHENOLOGY OF SPRING WEEDS IN NORMAN, OKLAHOMA

WM. T. PENFOUND
Department of Plant Sciences, University of Oklahoma, Norman

ABSTRACT. Weed calendars were kept for January-May 1954 and 1955, involving 75 species, more than half native. Details are given for the 25 most abundant. Percentage of those initiating flowering reached a peak in April; of those actually in bloom, about mid-May. A list and tables are given for the commonest species by month, growth habit, and habitat, with tables of temperatures and precipitation for the two seasons.

A study of the phenology of the weeds of Norman was initiated in January of 1954. The purposes of the investigation were to prepare a phenological calendar for the spring weeds and to determine the effects of weather on the phenology of these weeds. In practice field trips were made at least twice a week except during extended periods of cold or rainy weather. On each trip observations were made on foliation, exsertion of flower buds, flowering, fruiting and seed dissemination. From these data, graphic tables and phenological calendars were prepared.

RESULTS

During the two years of investigation, some phenological data were obtained on 75 herbaceous weeds in Norman. Some species that were present in 1954 were not found in 1955. On the other hand, eight new species were discovered in 1955. In analyzing the detailed record, for 1954 and 1955, it was observed that adequate records were obtained only on the more common species. In view of these facts, data are presented only on the 25 most abundant species.

On the species in Table 1, the dandelion, *Taraxacum officinale*, flowered discontinuously throughout the year, even in December and January. The first plant to initiate anthesis in the spring, therefore, was the shepherd's purse, *Capsella Bursa-pastoris*. Relatively few new species started to flower in February or March, most of the species initiated flowering in April and a few new ones began to flower in May (Table 1). The flowering period of spring weeds was found to be comparatively long. Many of the earliest flowering species had anthoperiods of twelve or more weeks. Because of this, the peak of flowering of weedy species occurs about May 15. This contrasts markedly with shrubs and trees which reach their flowering maxima about May 1 and April 15 respectively (Table 2).

In comparing the phenological weed calendars in 1954 and 1955 it will be observed that no species were in bloom by mid-February, 1954,

TABLE 1

Phenological calendar of more common weeds of Norman, Oklahoma, arranged in order, under the month in which flowering started.

January
Taraxacum officinale
Capsella Bursa-pastoris

February
Lamium amplexicaule
Veronica polita
Claytonia virginica

March
Stellaria media
Viola Kitaibeliana
Bromus catharticus

April
Monolepis Nuttalliana
Oenothera laciniata
Plantago virginica
Oxalis stricta
Medicago lupulina
Lepidium densiflorum
Bromus purgans
Trifolium repens
Pyrrhopappus carolinianus
Galium aparine
Rumex altissimus
Hordeum pusillum

May
Geranium carolinianum
Melilotus officinalis
Rumex crispus
Melilotus alba
Sorghum halepense

TABLE 2

Percentage of species in bloom at mid-month in Norman, Oklahoma

Item	February	March	April	May
Weeds, 1954	0	10	34	56
Shrubs, 1954	4	32	36	28
Trees, 1954	14	27	45	14
Weeds, 1955	6	20	23	51

and that there was a relatively low percentage in flower by mid-March, 1954 (Table 2). That this is not due to low temperatures is obvious since February and March of 1954 were at least as favorable for flowering as the same months in 1955 (Table 3). The precipitation, however, was very low in January, February and March of 1954 as compared to the precipitation in the same months of 1955, and undoubtedly was responsible for the low flowering rate in the early spring of 1954. Since relatively few species had flowered by mid-March of 1954, the percentage of plants in bloom during April was much higher in 1954 than it was in 1955 (Table 2).

The distribution of spring weeds is of some interest. Whether based on the total number of species or the more common (25) species, a lower percentage of species was found in both lawns and gardens than was present in either one alone (Table 4). Of greater interest was the fact that Norman weeds included fewer adventive plants than species

TABLE 3

Average monthly temperatures and precipitation in the spring seasons of 1954 and 1955

Month	1954	1955
Average monthly temperature		
February	51.3	39.8
March	47.5	49.5
April	65.6	64.1
May	63.0	70.6
Average monthly precepitation		
January	0.43	1.05
February	0.69	1.35
March	0.67	1.50
April	3.04	0.78
May	6.21	9.40

TABLE 4

Distribution and status of common weeds in Norman, Oklahoma. All figures in percent.

Species	Based on all (75) species	Based on common (25) species
In lawns only	39	36
In gardens only	41	40
In lawns and gardens	20	24
Native plants	56	52
Adventive plants	44	48
Grass family	23	16

native to the United States (Table 4). Also noteworthy is the fact that the grass family comprised about one-fifth of the total weedy plants (Table 4).

Discussion

In discussing the lateness of the spring of 1928, Gould (1928) attempted to base her discussion on the percentage of all plants which flowered later (or earlier) in 1928, as compared with 1927. When based on the start of flowering in the current study, it was found that the 1954 spring season (as compared with the 1955 season) was late in February but early in April. This suggests that spring may be early for certain species but may be late for other species during the same year depending on the weather.

Penfound, Hall and Hess (1945) believed that the flowering of plants in North Alabama in the early spring was "largely controlled by water, soil, and air temperatures". Leopold and Jones (1945) believed that precipitation, as well as temperature, was important in determining the phenological activities of plants. Piemeisel (1951) found that low water supply affected not only the flowering and seed

production of the current generation but also influenced the next generation. In desert plants Juhren, Went and Phillips (1956) discovered that temperatures which prevailed after each rain, together with the amount and duration of the rainfall were the major factors that brought about germination. In view of the above findings, and those of the current investigation, it is apparent that both temperature and soil moisture are important factors in plant phenology.

According to Leopold and Jones (1945), the anthoperiod of exotic perennial weeds is about 45 days. In the current investigation, some of the early-flowering species were in bloom for 140 days, whereas some of the later ones flowered for only 30 days. This variability was recognized by Leopold and Jones (1945) who advanced the important principle that "The year-to-year variability of events, as compared with their own averages, tends to be greatest in early spring, and decreases progressively through May."

SUMMARY

1. A study of the phenology of weeds of Norman, Oklahoma, was made during the spring seasons of 1954 and 1955.
2. *Capsella bursa-pastoris* was the first weed to bloom in the Norman area.
3. The percentage of weeds initiating flowering was low in January, February and March, reached a peak in April and declined during May
4. The percentage of weeds in flower at a given time increased slowly through January, February and March, mounted rapidly during April and reached a peak about the middle of May.
5. Temperature and precipitation are the major limiting factors in the flowering of weeds in the Norman area.
6. A greater number of weeds were found either in lawns or gardens than were common to both.
7. The weeds in the Norman area included more native than adventive species.

LITERATURE CITED

FEATHERLY, H. I. 1946. Manual of the grasses of Oklahoma. Okla. A&M. Coll. Bull. 21. 137 pp.

GOODMAN, G. J. 1956. Keys to the spring flora of Oklahoma. Mimeographed, Norman, Okla. 54 pp.

GOULD, LOIS. 1929. Lateness of the spring of 1928 as determined by comparison of first blooming dates. Proc. Okla. Acad. Sci. 9:43-46.

JUHREN, MARCELLA, F. W. WENT and EDWIN PHILLIPS. 1956. Ecology of desert plants IV. Combined field and laboratory work on germination of annuals in the Joshua Tree National Monument, California. Ecology 37: 318-330.

LEOPOLD, ALDO and SARA E. JONES. A phenological record for Sauk and Dane Counties, Wisconsin. Ecol. Monog. 17:81-122.

PENFOUND, WM. T., T. F. HALL and A. D. HESS. 1945. The spring phenology of plants in and around the reservoirs in North Alabama with particular reference to malaria control. Ecology 26:332-352.

PIEMEISEL, R. L. 1951. Causes affecting change and rate of change in a vegetation of annuals in Idaho. Ecology 32:53-73.

THE SOUTHWESTERN NATURALIST 1 (3): 125—132 JULY, 1956

CHROMOSOME NUMBERS AND GEOGRAPHIC DISTRIBUTION OF LINDHEIMERA, ENGELMANNIA, AND BERLANDIERA (COMPOSITAE-HELIANTHEAE-MELAMPODINAE)

B. L. TURNER AND M. C. JOHNSTON
Department of Botany, University of Texas, Austin 12

ABSTRACT. Chromosome counts for these three genera are reported for the first time, made for a total of five species. *Lindheimera* (x=8) has one species (*L. texana* Gray & Engelm.) in Oklahoma and Texas, a second (*L. mexicana* Gray) in Mexico. *L. texana* has large meiotic chromosomes, showing three or more chiasmata at metaphase. *Engelmannia* (x=9) is monotypic (*E. pinnatifida* T. & G.) and is widespread throughout southwestern U. S. and adjacent Mexico. *Berlandiera* (x=15) has four species in the southeastern and southwestern U. S. and Mexio; counts were made for three: *B. lyrata* Benth. var. *lyrata*, *B. pumila* (Michx.) Nutt., *B. texana* DC. var. *texana*, and *B. texana* var. *betonicifolia* (Hook.) T & G. Meiotic chromosomes of the two latter genera are smaller than those of *Lindheimera*, and show only two terminalized chiasmata at metaphase. From comparison of chromosomal information with that available for other members of the subtribe Melampodinae (including an unpublished report of x=10 for *Melampodium*), it is concluded that cytological evidence supports Asa Gray's opinion that the subtribe is an "artificial group."

Taxonomy and nomenclature of Texas species of *Berlandiera* is discussed and a key given for three taxa which have received varying treatment. *B. dealbata* (T. & G.) Small is merged with the earlier described *B. pumila* of the southeastern U. S. *B. texana* DC. is treated as a variable species which intergrades with *B. pumila* in eastern Texas, the numerous, seemingly intermediate populations from the latter area being treated as *B. texana* var. *betonicifolia*.

Asa Gray (1886) placed the genera *Lindheimera, Engelmannia,* and *Berlandiera* close together in his treatment of the subtribe Melampodinae of the Heliantheae. *Lindheimera* is represented by the single species *L. texana* Gray & Engelm. in the United States (a second species, *L. mexicana* Gray, occurs in Mexico). *Engelmannia* is monotypic; the single species *E. pinnatifida* T. & G. is widespread in southwestern United States and adjacent Mexico. *Berlandiera* is a larger genus in which the present authors recognize four species (two with two varieties each) in the southeastern and southwestern United States and Mexico. The genera are distinguished by a number of marked morphological characters and have never been a source of confusion at the generic level. Chromosome numbers have not previously been reported for any of them. All counts here given were made from pollen

mother cells. Buds were killed and fixed in a solution of 4 parts chloroform: 3 parts absolute alcohol: 1 part glacial acetic acid, and allowed to remain for several days. Young anthers were subsequently removed and squashed in acetocarmine. Below are listed the collections and corresponding *n* chromosome numbers of the taxa examined. Voucher specimens have been deposited in the University of Texas Herbarium. All collections were made in Texas.

	n number
LINDHEIMERA TEXANA. Fayette Co.: west of La Grange, *Turner & Johnston 54318*	8
..... Live Oak Co.: 3 miles n. of Three Rivers, *Thompson & Turner 20*	8
..... Travis Co.: Austin, *Johnston 54307*	8
ENGELMANNIA PINNATIFIDA. Travis Co.: Austin, *Johnston 54306*	9
BERLANDIERA LYRATA var. LYRATA. Grown in Austin from seed collected in Alpine, Brewster Co., *Johnston 541032*	15
BERLANDIERA PUMILA. Colorado Co.: 1 mile s.w. of New Ulm, *Turner & Johnston 54329*	15
..... Gonzales C.: 3 miles n. of Belmont, *Thompson & Turner*	15
BERLANDIERA TEXANA var. TEXANA. Bandera Co.: 2 miles w. of Bandera, *Turner 3841*	15
BERLANDIERA TEXANA var. BETONICIFOLIA. Bastrop Co.: 19 miles w. of Giddings, *Turner & Johnston 54357*	15
..... Fort Bend Co.: 2 miles e. of Fulshear, *Turner 3819*	15
..... Leon Co.: 14 miles s. of Fairchild, *Turner 3814* (this specimen approaching *B. pumila*)	15

To facilitate treatment, the genera will be discussed separately. Dot maps are based on specimens in the following herbaria: Gray Herbarium, Southern Methodist University, University of Texas. Grateful acknowledgment is made to the directors of these herbaria for the loan of material.

LINDHEIMERA

L. texana is an early spring annual. It occurs primarily on open calcareous soils and is known only from Texas and Oklahoma (Map 4). It is a common roadside weed in central Texas, and is known locally as Texas Star. The distribution of this species places it with the many "old" endemics centering on the Edwards Plateau. Meiotic chromosomes of *L. texana* (n=8) are large, having three or more chiasmata at metaphase (Fig. 1). Cytologically, the species is not like any other member of the Melampodinae thus far investigated. Both *Engelmannia* and *Berlandiera* have smaller chromosomes which show only two terminalized chiasmata at late prophase and metaphase.

ENGELMANNIA

E. pinnatifida is a late spring and summer-blooming perennial which produces annual stems from the crown of a large woody tap-

Fig. 1—6. Camera lucida drawings of meiotic chromosomes. Fig. 1. **Lindheimera texana** (n=8). Fig. 2. **Engelmannia pinnatifida** (n=9), anaphase of first division.. Fig. 3. **Berlandiera pumila** (n=15). Fig. 4. **B. texana** var. **betonicifolia** (n=15). Fig. 5. **B. t.** var. **texana** (n=15). Fig. 6. **B. lyrata** var. **lyrata** (n=15. All figures ca X 1500.

root. It occurs primarily on open calcareous soils from Nebraska to nothern Mexico (map 1). Meiotic chromosomes of *E. pinnatifida* (n=9) are comparatively large, with two terminalized chiasmata at late prophase. An anaphase configuration is shown in Fig. 2.

Some early workers regarded this genus as having close affinity with *Silphium*, but according to Gray (1886) it is closer to *Parthenium*. So far as known, *Engelmannia* is diploid with n=9; its meiotic chromosomes are comparatively large. *Parthenium* comprises taxa with polyploids apparently derived from species with base numbers of x=9; (Stebbins and Kodani, 1944), or 17 and 18 (Rollins, 1950). *Silphium*, so far as known, has a base chromosome number of x=7 (Tischler, 1950). The data on chromosome numbers would seem to support the opinion of Gray. *Engelmannia* and *Parthenium* are very distinct morphologically, but that they have been derived from a common ancestor seems a possibility.

Berlandiera

Berlandiera, as treated here, includes six taxa: four species and two varieties. The genus is distributed from Georgia to Arizona and south to central Mexico. Unlike *Lindheimera* and *Engelmannia*, it contains several intergrading species. Meiotic chromosomes are comparatively small, and characteristically form only two terminalized chiasmata at prophase (Figs. 3-6). Since the delimitation of the taxa in this genus has not been handled with consistency, the species (especially those occuring in Texas) will be discussed in some detail.

B. lyrata Benth. and *B. subacaulis* Nutt. appear to be closely related on the basis of their similar morphology. The latter is known only from Florida and will not be discussed further in this paper. *B. lyrata* var. *macrophylla* Gray is a distinct taxon occurring at high altitudes on limestone mountains (Guadalupe and Glass Mountains in Trans-Pecos Texas). Occasional specimens intermediate between this variety and var. *lyrata* (which occurs at lower elevations) may be found in herbaria, but these are few, and for the most part the taxa can be clearly distinguished by differences in habit and leaf features. Both varieties were recognized by Gray, and the present treatment does not differ appreciably from his.

The most perplexing complex in *Berlandiera* is that involving *B. texana* and *B. pumila*. These intergrade in eastern Texas to such a degree that it is often difficult to assign individuals from this area to either species. Shinners (1951) treated the Texas representatives

of this complex as three species: *B. texana, B. betonicifolia,* and *B. dealbata.* His key apparently was based upon generally typical material and does not allow for the numerous intermediate types which we have observed in nature. The present authors treat *B. betonicifolia* as a variety of *B. texana* (as did Gray), and refer *B. dealbata* to the southeastern *B. pumila.* We distinguish the taxa of this complex as follows:

1a. Upper 10 cm. of stem (from below peduncles of flowering heads) typically bearing 1-4 leaves, all of them distinctly petiolate; main stem typically bearing 1-5 heads (intergrades with *B. texana* var. *texana* in southern Texas, with *B. t.* var. *betonicifolia* in eastern Texas) ..... 1. *B. pumila*

1b. Upper cm. of stem typically bearing 5-15 leaves (these often much reduced), those on upper portion of stem distinctly sessile; main stem bearing (2) 3-many heads at maturity; plants usually tall and robust

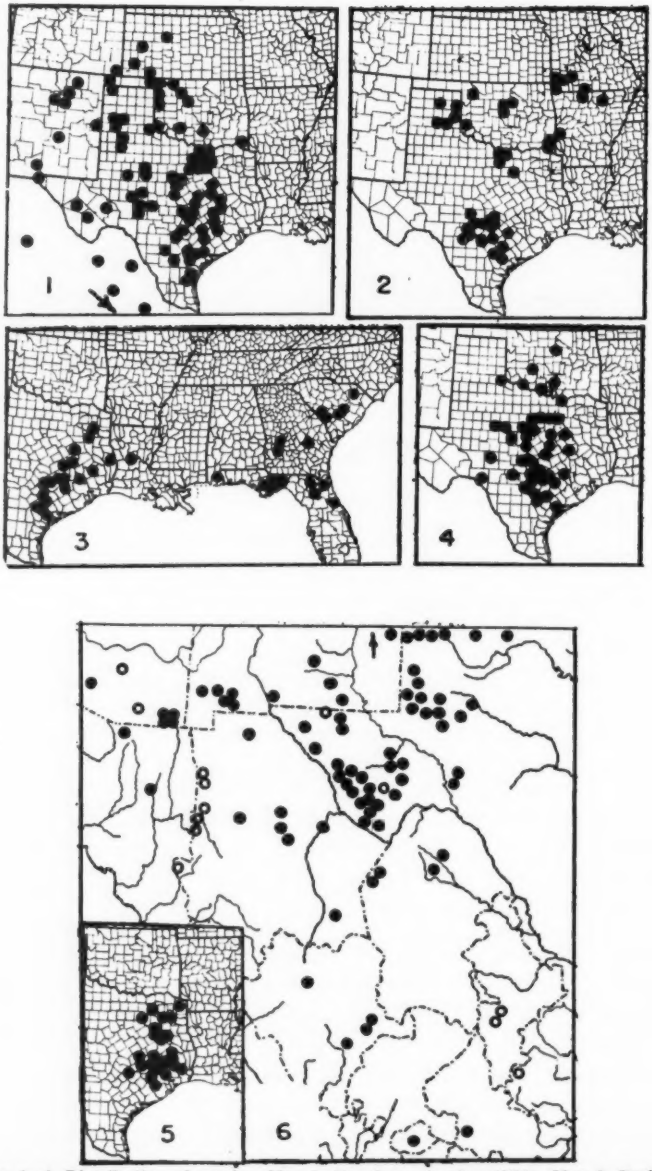
2a. Peduncle with a distinct stiff spreading pubescence, the hairs not densely woolly-matted: clay and limestone soils of south-central Texas to Oklahoma, Arkansas, and Missouri (intergrades with var. *betonicifolia* in eastern Texas) ..... 2a. *B. texana* var. *texana*

2b. Peduncles with soft, densely woolly-matted pubescence; sandy soils of eastern Texas (many specimens keying here appear intermediate between *B. pumila* and *B. texana* var. *betonicifolia*
2b. *B. texana* var. *betonicifolia*

1. B. PUMILA (Michx) Nutt., Trans. Amer. Phil. Soc. ser. II. 7: 342. 1841. *Silphium pumilum* Michx., Fl. Bor.-Am. 2: 146. 1803. (Type from Florida; not examined.)—*Silphium tomentosum* Pursh, Fl. Am. Sept. 2: 579. 1814. (Type collected by Bartram in Georgia; not examined.) *Berlandiera tomentosa* (Pursh) Nutt., Trans. Amer. Phil. Soc. ser. II. 7: 342. 1841.—*Berlandiera tomentosa* var. *dealbata* T. & G., Fl. N. A. 2: 282. 1842. (Type or isotype examined, collected by Nuttall in "Arkansas"; in Gray Herb.) *B. pumila* var. *dealbata* (T. & G.) Trel., Rep. Ark. Geol. Surv. 1888, 4: 193. 1891. *B. dealbata* (T. & G.) Small, Fl. S.E. U.S. 1246 and 1340. 1903.

Sandy soils of the southeastern United States (Map 3). Texas material of this species cannot be separated from that of South Carolina, Georgia, Florida, and Alabama. The lack of material from Mississippi is perhaps due in part to inadequate collecting in this area.

The name *B. tomentosa* var. *dealbata* has been applied to small, extremely floccose-stemmed and -leaved forms of this species from sandy soils to south-central Texas (occasionally from elsewhere). The type (cited above) is a small plant, having few leaves, with well-developed petioles. It appears to be fairly typical *B. pumila.* Gray (1886) apparently changed his concepts or redefined the variety, including



Maps 1—6. Distribution of species. Map 1. **Engelmannia pinnatifida.** Map 2. **Berlandiera texana** var. **texana.** Map 3. **Berlandiera pumila.** Map. 4. **Lindheimera texana.** Map 5. **Berlandiera texana** var. **betonicifolia.** Map 6. **Berlandiera lyrata** var. **lyrata** (disks); **B. l.** var. **macrophylla** (circles). Arrows indicate that a few collections are known somewhat outside the areas mapped.

in *B. dealbata* some plants which the present authors assign to *B. texana* var. *betonicifolia*. Indeed, he remarked that *B. tomentosa* var. *dealbata* "varies into a less canescent state of *B. texana*."

2a. B. TEXANA DC. var. TEXANA, Prodr. 5: 517. 1836. (Isotype examined, *Berlandier Pl. Exs. 2044*, from Texas; in Gray Herb.) Calcareous, often silty soils (usually along dry stream beds) of south-central Texas to Oklahoma, Arkansas, and Missouri (map 2). Typical material is easily distinguished by the coarse, spreading pubescence of the stem and peduncle, and by the mostly sessile leaves. In south-central Texas populations occur which are composed of smaller plants with somewhat petiolate leaves on the lower portion of the stem, and with softer, often rather floccose pubescence (characters somewhat intermediate between those of *B. pumila* and *B. texana* var. *texana*). Additional field study may indicate the desirability of treating these populations as yet a third variety of *B. texana*, or perhaps as a variety of *B. pumila*.

2b. B. TEXANA var. BETONICIFOLIA (Hook.) T. & G., Fl. N. A. 2: 281. 1842. *Silphium betonicifolium* Hook., Comp. Bot. Mag. 1: 99. 1835. (Isotype examined, *Drummond*, from "New Orleans"; in Gray Herb.) *Berlandiera betonicifolia* (Hook.) Small, Fl. S.E. U.S. 1246 and 1340. 1903.—*Berlandiera longifolia* Nutt., Trans. Amer. Phil. Soc. ser. II. 7: 342. 1841. (Type collected by Nuttall, "plains of Red River, Arkansas" (i.e. Oklahoma); not located.) From the description, Nuttall's species appears to belong to the assemblage of *B. texana-B. pumila* intermediates.

Sandy soils of eastern Texas, Arkansas, and Louisiana (Map 5). This is a highly variable taxon and appears to link var. *texana* with *B. pumila*, intergrading with the former in northeastern Texas and with the latter in southeastern Texas. Isotype material (with purplish hairs on the peduncle) can be matched with material from Polk Co., Texas. Gray questioned the correctness of the locality "New Orleans," but it is not unlikely that Drummond collected such material there.

GENERAL REMARKS

The subtribe Melampodinae contains 22 genera (Hoffmann, 1897). According to Gray (1886), it is an "artificial group." Chromosomal counts are available for 14 species of 6 genera within the subtribe. These are summarized below. Data for *Melampodium* are from Robinson (1901) and the Gray Herbarium Card Index as of 1 January, 1957;

the single chromosome count from Turner (unpublished). Data for *Parthenium* are from Rollins (1950), those for *Silphium* from Perry (1937) and Tischler (1950).

	Species recognized	*Species counted*	*Base number (x)*
LINDHEIMERA	2	1	8
ENGELMANNIA	1	1	9
BERLANDIERA	4	3	15
MELAMPODIUM	51	1	10
SILPHIUM	23	1	7
PARTHENIUM	16	11	17, 18

Evidently the subtribe, as delimited by Gray and Hoffmann, is a multibasic taxon composed of genera having, so far as known, base chromosome numbers of $x=7, 8, 9, 10, 15, 17, 18$. The large chromosomes with numerous chiasmata in mieotic metaphase found in the genus *Lindheimera* are quite marked, and combined with the haploid number of 8 separate it from others of the subtribe for which cytological information is available. Thus the chromosomal evidence, though admittedly fragmentary, supports the opinion of Gray, that the subtribe Melampodinae is an artificial assemblage. Chromosome counts are not available for most of the Heliantheae. Hence any attempt to relate anomalous genera (such as *Lindheimera*) to other genera or subtribes of the Heliantheae on the basis of cytological information would be premature.

LITERATURE CITED

GRAY, A. 1886. Synoptical Flora of North America (revised reprint) vol. I pt. 2. (Summary of Melampodinae, pp. 60-62.)

HOFFMANN, O. 1897. Compositae. Engler & Prantl, Die Natürlichen Pflanzenfamilien IV. 5: 87-391. (Melampodinae, pp. 214-219.)

PERRY, LILY M. 1937. Notes on *Silphium*. Rhodora 39: 281-297. (Contrib. Gray Herb. CXVIII-1.)

ROBINSON, B. L. 1901. Synopsis of the genus *Melampodium*. Proc. Amer. Acad. 36: 455-366. (Contrib. Gray Herb. n. s. XX-1.)

ROLLINS, REED C. 1950. The guyaule rubber plant and its relatives. Contrib. Gray Herb. CLXXII. 73 pp.

SHINNERS, LLOYD H. 1951. Notes on Texas Compositae—VIII. Field & Lab. 19: 133-136. (*Berlandiera*, p. 135.)

STEBBINS, G. L. and M. KODANI. 1944. Chromosomal variation in guyaule and mariola. Jour. Heredity 35: 161-172.

TISCHLER, G. F. L. 1950. Die Chromosomenzahlen der Gefässpflanzen Mitteleuropas. 's Gravenhage, Junk. 263 pp. (*Silphium*, p. 150.)

THE SOUTHWESTERN NATURALIST 1 (3): 133—139 JULY, 1956

NOTES

BLOWGUNS FOR REPTILE SAMPLING—Blowguns have proved more efficient devices for obtaining lizards than techniques previously employed. The blowguns were constructed of Reynolds aluminum tubing with outside diameter of 3/4 of an inch and a bore of 5/8 of an inch, the smallest bore available in this tubing. The six foot length is most readily available and sells for $1.50; gun lengths of eight, six, four and two feet were tested. The eight foot gun was less efficient because of too great friction between the gun and dart, and because a gun of this length is unwieldy. Guns shorter than four feet were inefficient because of power loss and impaired accuracy. The guns four and six feet were effective; choice of lengths depends upon the operators' preference and shooting conditions.

The dart was made by selecting corks which fit one-half of their length within the tube, but not so tight that friction overcomes the forward thrust into the tube, and shaving the larger end of the cork until a snug fit was achieved. The fit must be tight enough to prevent the cork from slipping of the dart. A cork that exactly fits the tube without modification has proved unsatisfactory. Because of the narrow rim of contact between such a dart and the tube, accuracy is poor as the dart shimmies within the tube. One trip was unsuccessful because this type dart was used exclusively.

Corks without needles were too light for accuracy except at close range and often did not stun the lizard sufficiently to allow the collector to capture it before it revived. Weights glued into corks were usually lost after the first few shots. Long carpet needles furnish adequate weight to the dart and the lizard is always pinned and held by the needle. Other satisfactory dart points were made with stainless steel wire. Fifty percent of specimens shot survive, and rarely are the scales significantly damaged by the dart.

Finishing nails in corks were accurate, but the lizard was often damaged. Nails do not stick in objects such as logs or trees as well as do needles, so more darts are lost. Neither accuracy nor force were noticeably increased by attaching fins to the dart.

The needles should be inserted one-half way into the cork, blunt end first. If the needle is inserted point first and pushed through the cork, the force of contact of needle with object when the dart is discharged, will force the needle through the rear end of the cork, and after a few shots so loosen the needle that it is easily lost. When wire points were used, greatest accuracy was obtained by inserting the wire through the cork with the short end of the wire projecting through the cork porteriorly.

Fingernail polish makes the corks easily visible and restores a tight fit in the tube as corks become worn. Darts are inserted in the oral end of the tube about 1/2 inch from the end and expelled by a short puff of air from the chest. In a test of accuracy using the four foot gun, darts were shot ten times each at a target three inches in diameter from 9, 12, 15, 18, and 21 feet. Every shot from distances up to 12 feet hit near the center of the target. At 15 feet accuracy was 80 per cent and at 18 and 21 feet, 40 per cent. Trajectory of the dart causes considerable decrease in accuracy in the field at distances greater than 12 feet, but it is seldom necessary to shoot a lizard at a distance exceeding 10 feet.

The blowguns have been used in many habitats in several parts of the country. Ten miles northwest of Lucedale, Greene County, Mississippi. 39 lizards were taken (13.0 per gun hour) including 24 *Cnemidophorus sexlineatus*, 10 *Sceloporus undulatus*, 3 *Eumeces fasciatus*, and 2 *Anolis carolinensis*. Seventeen miles southeast of Dallas,, Dallas County, Texas, 17 lizards were collected (17.0 per gun hour) including 13 *Cnemidophorus sexlineatus*, 3 *Sceloporus undulatus hyacinthinus*, and 1 *Lygosoma laterale*. In the north Palo Duro Canyon, Randall County, Texas, 124 lizards were shot (8.9 per gun hour) including 69 *Uta stansburiana steinegeri*, 11 *Cnemidophorus tessellatus*, 38 *Sceloporus undulatus consobrinus*, 3 *Holbrookia maculata maculata*, and 3 *Crotaphytus collaris collaris*.

The blowgun is effective even against swift terrestrial and arboreal lizards, and large samples needed for statistical studies or for reproductive information are easily obtained. An accuracy of 80 to 90 per cent is common after the operator becomes experienced at using the gun.

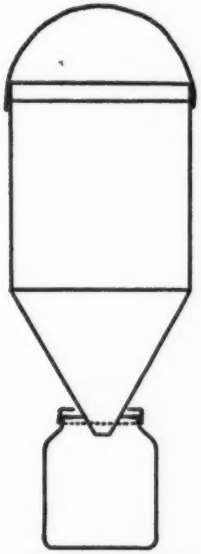
Rubber guns and shot pistols are the techniques commonly used in lizard sampling. The blowgun is an improvement over the rubber gun in power, accuracy and speed of shooting. The blowgun, as effective as the shot pistol, is cheaper to obtain and operate and is not objectionable to landowners who will allow no firearms on their farms or ranches.

A sling may be fitted to the gun using hose clamps for tying locations. With some modification this gun was used to obtain small birds and mammals.

The authors wish to thank Mr. Robert G. Webb of West Texas State College, Mr. Whitfield Gibbons of Tuscaloosa, Alabama, and Mr. Douglas Landwehr of New Orleans, Louisiana, for assistance in the field.—*Donald W. Tinkle, Biology Department, Texas Technological College, Lubbock; William C. Lawrence, Department of Zoology, Tulane University, New Orleans, Louisiana.*

A MODIFIED BERLESE FUNNEL FOR COLLECTING MAMMALIAN AND AVIAN ECTOPARASITES.—In the course of epidemiological investigations concerned with the collection of live ectoparasites, mainly flies and ticks, from mammals and birds, the need for a relatively quick and efficient method of collection became apparent. The usual collection techniques involve placing the animal in a plastic bag after capture to prevent loss of ectoparasites from the dead host. The animal is then brought into the laboratory where the rather tedious process of combing and brushing the pelage in a deep enameled pan is used to recover those parasites still on the host. When the degree of infestation is light this method is quite suitable, but a less time-consuming method is desirable when the host animal is heavily infested with ticks or fleas. Other methods of collection were considered but were not suitable for various reasons. That of Cook (1954) was not applicable to living forms whereas the method of Lipovsky (1951) was found unsuitable because of the necessity of washing the skins in a detergent solution thus making the specimen unusable for other purposes. The methods of Ryckman et al. (1954) and of Sengbusch (1956) involve apparatus which we found impractical for general field use.

The apparatus shown in the figure was devised to remove fleas and ticks from heavily parasitized birds and mammals and has proven reasonably successful in field operations. It is hoped that other workers may find use for the apparatus, subject to certain limitations described below.



The device consists of a 10-gallon lard can about 12 inches in diameter, with the bottom removed and replaced with one-quarter inch mesh hardware cloth. A sheetmetal funnel is soldered over the bottom of the can. A hole approximately 1 inch in diameter is cut in the flat lid of a two-piece screw-top jar fitting any standard narrow-mouthed Mason jar. The outer part of the lid is first placed over the funnel and the perforated lid is then soldered over the end of the funnel. A narrow mouthed Mason jar of any size can now be screwed onto the end of the funnel. A smaller version for use on small animals can be made with a 1-pound tobacco can and a tin funnel 5½ inches in diameter which can be purchased in any hardware store.

The funnel when in use is suspended over a tree branch in the area of trapping or hunting. Heavily infested animals are placed in the funnel as soon as possible after killing them and the cover put on the can. As the carcass cools the ticks and/or fleas start leaving the host and drop through the hardware cloth mesh into the funnel. About an inch or two of water is placed in the jar for the collection of living specimens. If it is desired to kill and preserve ectoparasites for later determination 85% ethyl alcohol may be placed in the jar. In practice it was noted that the funnel seemed to work less efficiently on cool days when the parasites apparently remained longer on the dead host, but we have insufficient time-temperature data to confirm

this observation. The size and rate of cooling of the host undoubtedly affect the departure rate of ectoparasites. About half of the ticks have departed, in most cases, by the end of the first hour in the funnel. An hour and one-half to two hours more in the funnel did not add as much as expected to the total recovery of ticks. In several cases, at the end of 150-175 minutes in the apparatus from 17 to 38 per cent of the total number of ticks were still on the hosts. However, those remaining were mainly deeply imbedded and well engorged adults. These must be removed with forceps. The method has not been found suitable for routine recovery of mites.

Some counts were made of the total number of larval, nymphal and adult ticks recovered in the Berlese apparatus. In all rabbits berlesed in which such counts were made, recoveries were about 10 per cent larval, 47 per cent nymphal and 43 per cent adult ticks. Those ticks found on the host after berlesing were nearly all adults.

The usefulness of the apparatus is limited to some extent by the fact that only one animal can be processed at a time, unless a pooled sample is desired. Usually, however, only one or two heavily infested animals are obtained in one day and the remainder can be processed by hand brushing and combing in the laboratory. Also in summer the time required for collection of ectoparasites in this way may render the carcass useless for other purposes. Thus far, the device has been most useful in collecting fleas and ticks from heavily infested rabbits. Although no rabbits heavily infested with fleas were encountered, the few fleas on some of the rabbits left the dead host very rapidly and it is very probable that most of the fleas would be recovered in the space of 30 minutes.

It is possible that the device might also be used in collecting ectoparasites or other invertebrates from ground litter. A relatively large quantity of litter might be placed in a can, which could then be closed. If placed in sunlight, the heat generated in the can would effectively drive out many of the arthropods ond other invertebrates concealed in the litter.—*J. A. Sealander and C. E. Hoffman, Zoology Department, University of Arkansas, Fayetteville*

LITERATURE CITED

COOK, E. F. 1954. A modification of Hopkins' technique for collecting ectoparasites from mammalian skins. Ent. News 65: 35-37.

LIPOVSKY, L. J. 1951. A washing method of ectoparasite recovery with particular reference to chiggers (Acarina-Trombiculidae). J. Kans. Ent. Soc. 24: 151-156.

RYCKMAN, R. E., K. C. FISHER and C. T. AMES. 1954. An apparatus for collection of ectoparasites from mammals. Calif. Fish & Game 40: 75-76.

SENGBUSCH, H. G. 1956. A modified Tullgreen funnel for the collection of small invertebrates (Mesobiota) in soil. Turtox News 34: 226-228.

EFFECTIVENESS OF JAPANESE MIST NETS FOR SECURING BATS IN TEMPERATE LATITUDES.—Recently Delquest (Trans. Kansas Acad. Sci. 57 (1): 1-10, 1954) published an account of the successful use of Japanese fowling nets in securing bats in the American tropics. He reported that bats could be taken in a variety of situations in the open, and that often the species secured in this fashion were not taken at all by other means. He further noted that nets set in buildings and caves yielded very indifferent results.

The writer secured three of these nets a few years ago, hoping to use them successfully in temperate latitudes. (They are obtainable from W. B. Davis, Box 254, FE, College Station, Texas.) The first opportunity to experiment

with them came in the summer of 1954, when several attempts were made to trap bats over water, under trees, and in forest openings in the vicinity of Stillwater, Oklahoma. Numerous birds were caught and on one occasion a sagging net entangled numerous small bullhead catfish, but only one bat, a *Lasiurus borealis* was secured. Use of the nets was abandoned, although they were usually taken along on field trips.

In June of 1955, the writer and two assistants, Nelson Cooley and Claud Ward, were in eastern Oklahoma collecting bats both by shooting and by examining the interiors of caves. Not many bats were being taken, and it was decided, as an experiment, to hang a net across the mouth of a cave that was located only a few miles from camp. The cave was one formed by dissolution of limestone, and while its mouth was large, the interior was very difficult to explore due to the narrow, tortuous water channels. Although it had been examined on several other occasions, no bats except *Pipistrellus subflavus* had ever been taken there. The net was hung at approximately 9:30 p.m. and was revisited at 11:00 p.m. Numerous pipistrels were found in the net, and in addition there were several *Eptesicus fuscus*, and two *Myotis keeni*. Numerous holes in the net indicated where other bats had become entrapped but had broken through. While these bats were being extricated others continued to be caught. A single *Myotis grisescens* was secured, three more *M. keeni*, and numerous *Eptesicus* and *Pipistrellus*.

Following this experience it became a nightly procedure to seek out a cave and place a net over it. During twilight bats would be collected by shooting, and vigil would then be kept beside the net until ten or eleven o'clock. By this means it was possible to take bats from caves that were impossible to explore satisfactorily, and to increase the number of species recorded from caves that had previously been explored.

One problem encountered was that of placing a net properly over a cave with a vertical shaft for an entrance. Many caves in Oklahoma are of this type and often the opening is only a few feet wide. It was found that the net can be placed at a very flat angle over the opening, and tilted so as to face the direction from which bats are most likely to approach. This method is not as satisfactory as hanging the net vertically, for it requires closer attention on the part of the collector. Bats dive into the net, but do not become entangled, and so are able to fly up off of its surface. The attendant must be alert in order to secure the specimen as soon as it touches the net.

On a few occasions a net was placed over the entrance of a cave known to be occupied by colonial species of *Myotis*, either *grisescens* or *velifer*. While the work of three collectors was required to keep the common kinds cleared from the net, the results were encouraging in that several uncommon kinds were secured as well. By this means the presence of the bunker bat, *Antrozous bunkeri*, was determined for the first time in western Oklahoma (exclusive of the panhandle) at Alabaster Cavern, where in two evenings a series of thirty was obtained. It was also discovered that large numbers of *Tadarida mexicana*, *Corynorhinus rafinesquei* and *Eptesicus fuscus* were utilizing these caverns at night. During the daytime only *Myotis velifer* may be observed in any considerable number.

In Cimarron County during August of 1955 a net was set on two successive nights across cave entrances in the Mesa region near the Cimarron River.

Only bats of the genus *Antrozous* were taken, but these proved to be so numerous that the net was used only for approximately two hours after dark on each occasion. A total of over 60 bats was obtained and many more were seen to pass over or under the net as the creatures flew repeatedly in and out of the caves.

On one other occasion in August of 1955 in the Wichita Mountains near Mountain Park, a net was placed within a cavernous place under a pile of huge granite boulders. Three *Corynorhinus rafinesquei* and two *Myotis subulatus* were taken in this situation. Neither species was encountered during the twilight period on the outside.

These and numerous similar experiences have shown that silk nets can be used effectively for sampling the populations of cave-dwelling bats in temperate latitudes. Ordinarily a greater variety of species may be secured with nets than by examining the interiors of the caves themselves. The method is particularly useful where the caves are of such a nature that the interiors cannot be completely explored.

Observations by the writer lead him to believe that bats, both when approaching or leaving a cave, fly as much by memory as by echolocation. Even when there is no shrubbery or screen of trees about the cave they will usually fly directly in, and often strike the net without any visible manifestation of having detected it. On other occasions individuals may detect the net, avoid it, circle as if to reorient themselves, and then plunge headlong into it. To the writer this behavior suggests strongly that the bats are able to fly through familiar surroundings by memory.

The field work reported in this paper was made possible by a research grant from the U.S. Public Health Service. Contribution No. 253, Zoology Department, Oklahoma A&M College.—*Bryan P. Glass, Department of Zoology, Oklahoma A&M College, Stillwater.*

AN ARBOREAL NEST OF THE FIVE-LINED SKINK, EUMECES FASCIATUS, IN EASTERN TEXAS. The Five-Lined Skink, *Eumeces fasciatus,* is considered by most authors as essentially a terrestrial form, while its relative *Eumeces laticeps* is considered primarily arboreal. Hence the discovery of an arboreal nest of *fasciatus* is of particular interest in regard to the degree of ecological isolation of these partially sympatric species. Observations recorded herein were made on a study area of 38 acres located 3.6 miles west of Dallardsville, Polk County, Texas. The sandy soil of this area supports a pine and hardwood forest characteristic of the Austroriparian biotic province of Blair (1950). Within the local study area are several spring fed creeks offering a constant water supply for small vertebrates. Decaying logs and dead trees are commonly dispersed among the long leaf and short leaf pines and mixed hardwoods. *E. laticeps* has not been observed to inhabit the study area.

The *fasciatus* nest was accidentally located on June 21, 1956 in a hollow chamber of a dead tree, *Sassafras albidum,* twelve feet nine inches from the ground. The tree was six inches in diameter. I was only aware that this tree contained such a nest after it was literally pushed to the ground. When the tree fell a skink ran out of, and quickly returned to the hollow thereby attracting my attention. Closer inspection revealed the presence of two female skinks with a nest of four well developed eggs. The eggs were mottled brown and were situated in the moist decaying wood. They were apparently

not injured when the tree fell. Both skinks were highly excited and made no attempt to guard the nest. The small portion of the tree trunk containing the nest was removed to the laboratory. Three of the eggss hatched on July 7, 1956. Snout-vent measurements of all three hatchlings were 25.6 mm.; tail lengths were 35 mm., 34.6 mm., and 35.5 mm. The two adults, now Texas Natural History Collection Numbers 21596, 21597, had a snout-vent and tail lengths of 54 mm., 83 mm., and 57 mm., 87 mm., respectively.

The presence of two females in a nest with such a small number of eggs is difficult to explain. Several hypotheses can be put forth, e.g., that the skinks in question are young females, and there is an increasing amount of evidence to show that in lizards reproductive potential is correlated with age and size. Also, some of the eggs could have perished through predation or natural loss and only four of the larger communal nest survived. The real explanation is likely a combination of the two hypotheses.

Parker (1948) recorded arboreal tendencies of *fasciatus* in western Tennessee. Blanchard (1922) described an arboreal nest of *Eumeces*, also in Tennessee, quite similar to my observations but the distinctness of *fasciatus* and *laticeps* had not been shown at that time. Fitch (1954) has recently made an excellent study of the ecology of *fasciatus* in which "more than one hundred natural nests were found, of which just one . . . was in decaying wood beneath the bark of an old log. All other nests were beneath rocks." Such a rocky terrain is non-existent in Eastern Texas and thus cannot be a potential nesting site for the *fasciatus* population. Hence it must utilize the existing habitat to survive and this it does, nesting in decaying logs and occasionally in the hollows of dead trees, perhaps more frequently than previously thought. On several occasions I have observed *fasciatus* on trees, even running to a height of 15 feet. Ecologists would find more nests in logs than in trees for ostensible reasons and thus the paucity of recorded arboreal nests.

The arboreal or terrestrial habit as an isolating mechanism between *fasciatus* and *laticeps* is perhaps not so complete as the literature indicates. Size and innate behavioral patterns may be the primary mechanisms of reproductive isolation.—*J. P. Kennedy, Department of Zoology, University of Texas, Austin 12.*

LITERATURE CITED

BLAIR, W. FRANK. 1950. The biotic provinces of Texas. Texas J. Sci. 2 (1)): 93-117.

BLANCHARD, FRANK N. 1922. The amphibians and reptiles of western Tennessee. Occas. Pap. Mus. Zool. Univ. Michigan 117: 1-18.

FITCH, HENRY S. 1954. Life history and ecology of the five-lined skink, Eumeces fasciatus. Univ. Kansas Publ. 8: 1-156. 26 figs., 17 tables, 2 pls.

PARKER, M. V. 1948. A contribution to the herpetology of western Tennessee. J. Tennessee Acad. Sci. 22: 20-30.

THE SOUTHWESTERN NATURALIST 1 (3): 140—144 JULY, 1956

REVIEWS

A MANUAL OF PARASITIC MITES. E. W. Baker, T. M. Evans, D. J. Gould, W. B. Hull, and H. L. Keegan. Published by the National Pest Control Association, Inc., 30 Church St., New York 7, N. Y. 170 pages, 59 figures. $4.25.

Here is an attractive little manual that should prove both useful and interesting to many readers. The manual treats about eighty species of mites. some of proven importance, some only potentially important, and some known to be unimportant but included because they are frequently found in association with animals. For each species there is given a discussion of the mode of action, symptoms, and general economic importance; a brief description; the biology or life history; control means; and the pertinent literature references. Fifty-nine of the included species are illustrated.

The book contains a brief introduction; technique of collecting, mounting and studying mites; and labeled line drawings illustrating the major morphological feature of adult female gamasids and of trombiculid larvae. There is also a key to the included species but its value is doubtful. Since most of the species are illustrated (with the incomparable drawings of E. W. Baker and T. M. Evans) identification would be more simply accomplished by thumbing through the book and comparing with the illustrations; that and looking up the host.

To the present reviewer, the chief value of the manual is in its general discussion of each species. This is in nearly all cases a succinct digest of all the available knowledge pertaining to that species. The suggestions for control would be of most interest to some readers, and to the credit of the author and publisher it must be said that control recommendations are as up to date as it is possible to be in a published manual of this sort.

The manual is primarily for the lay acarologist. The scientific names employed are taxonomically accurate and up to date (followed in all cases by a common English name), but there is no burden of synonymy, homonymy. historical review or any other of the trivia so dear to the heart of the specialist.

The flyleaf title states "A Manual of Parasitic Mites of Medical or Economic Importance." This pretty well indicates its scope. Within these limits. the manual serves its purpose very well.—*R. W. Strandtmann, Texas Technological College, Lubbock.*

GAMAZOVYE KLESHCHI (GAMASOIDEA). (THE GAMASID MITES. GAMASOIDEA.) N. G. Bregetova. Press of the Academy of Sciences of the U.S.S.R., Moskva-Leningrad, 1956. 247 pages (10½ x 7 in.), 563 figures. In Russian.[1]

This is the sort of manual that every taxonomist dreams of producing. but rarely indeed does one find a publisher. It deals with the mites of the superfamily Gamasoidea (which includes the laelaptid, dermanyssid, and

[1] Price not known. Russian publications are obtainable in this country through Four Continent Book Corporation, 253 Fifth Ave., New York 16, and Stechert-Hafner, Inc., 31 East Tenth St., New York 3.—**Editor's Note.**

related families) that are found in the U. S. S. R. It includes 6 families. 17 genera, and 32 species of non-parasitic mites which are not infrequently found in the nests of animals. The truly parasitic forms number 6 families, 27 genera, and 96 species. All but a few species are excellently illustrated, and this is precisely what makes the manual useful to the American worker The illustrations are so extensive, and point up the salient taxonomic characters so well, that even with a Russian reading rating of zero it is still possible to find the book valuable.

The manual consists of one and a half pages of preface; a list of the included families, genera, and species; an introduction of 40 pages; a systematic treatment of the species (157 pages); life histories and biologies of 5 common mites, including *Ornithonyssus bacoti, Dermanyssus gallinae, Allodermanyssus sanguineus, Sauronyssus saurorum,* and *Ophionyssus natricis;* references and indexes.

The Introduction includes chapters on characteristics of the superfamily Gamasoidea; ecology of the gamasoid mites; the immature stages and biology; epidemiology and epizoology; detailed morphological characters of the various families; a chapter on what appears to be "how to study mites"; and preparation of mites for microscopic study.

The systematic portion is handled entirely in 'keys'. First there is a key to the life stages, then to the families, and from there to genera. Under each genus there are two keys to species, one for the females, another for the males. As each species is reached in the key to females, the author gives its distribution and hosts. No bibliography or synonymy is given except in rare instances. Distributions are given in Russian as are also the hosts but at the end of the book there is a host list printed in Latin, giving the mites found on each host. Five new species are described and one new name proposed.

The list of references is extensive and alphabetized in two parts, the first part listing the Russian authors and printed in Russian characters; the second part listing the non-Russian authors and printed in Latin. The index to mite taxons is in Latin. Following this is an index to hosts which is printed in Russian for the common name and in Latin for the scientific name.

The taxonomic treatment differs only slightly from that of Vitzthum and is sound, although it varies somewhat from this reviewer's concepts.

Within the last 10 years, Russian acarology has become something to be reckoned with. Such authors as Lange, Zemskaja, Zachvatkin, Dubinin, Bregetova, and others have made, and are continuing to make, very significant contributions to the study of mites.

This is an attractive book, printed on good paper and bound in stiff paper covers.—*R. W. Strandtmann, Texas Technological College, Lubbock.*

FLOWERS AND THEIR HISTORIES. Alice M. Coats. 348 pages, 16 plates (8 in color). Hulton Press Limited, London. 1956. 30 shillings. (Obtainable on direct order from Henry Cork, 73 Queenswood Road, London, S.E. 23, England, for $4.20 plus postage.)

This I am sure was not intended as a book of humor, but such, among many other things, it surely is. There are humorous stories enough—like the old one of Walter Savage Landor throwing his cook out of the window, then rushing out exclaiming "Heavens! I forgot the violets!"—but much funnier are some of the old uses and methods of handling plants. We learn, for example, that a syrup made from sweet violets was blended with sulfuric acid as a medicine for children: "put into an ounce of the sirupe eight or nine drops of oile of vitrioll .... sucking children may take it without any perill" (according to Gerard's *Herball* of 1597). About poppies the author tells us, "The Latin name *Papaver* comes from the same root as the old Celtic word Pap, possibly because infants were given food doctored with poppy juice, to make them sleep; but another interpretation suggests that the Ancient Romans, with lamentable table manners, derived the name from the sound made when chewing the seed." Curious sidelights are given on one popular type of primrose. An admirer is apt "to be startled on learning that the object of his adoration has a singular propemsity for meat, and that a good part of its bloom is actually owing, like an alderman's, to this consumption of flesh. Juicy pieces of meat are placed about the root, so that it may in some measure be said to live on blood." One devotee who published a book on these flowers in 1815 "was notorious for the elaborate and nauseous composts he concocted for his plants, the odour of which rendered him extremely unpopular with his Barnet neighbors. A principal ingredient was goose-dung; but three geese purchased especially for the purpose of providing it, unfortunately broke loose and retorted by destroying or damaging all their owner's cherished auriculas." The Madonna lily, reportedly now occurring wild in all countries once included in the bounds of the Roman Empire, was supposed to have been planted at the sites of legion camps. But neither esthetics nor religious fervor were motives; the plant was once used for curing corns.

The author has ransacked fabulous libraries of old books and even incunabula (she unfortunately does not tell us anything about the collections to which she had access). For all the common (and some uncommon) border flowers and herbs of English gardens (woody plants are not treated), we are given a rich harvest of selected tidbits about the plants as they were seen by religious mystics of the Middle Ages, by the herbalists, by the later apothecaries and chirurgiens, by the early gardeners, by literary and historical figures; with stray glimpses back to Roman, Greek, and even Egyptian times, and ventures into etymology and mythology. At the end of the book is a group of short biographies of noted gardeners and plant explorers who introduced horticultural material into English gardens. Though only a sort of sampler, rather than exhaustive account, this is a thoroughly scholarly work, delightfully laced with the author's own dry wit as well as the sometimes hilarious quotations from old horticultural and botanical works. Among the plants treated are an impressive number of Americans, such as annual gaillardias and annual phlox from the Southwest, to mention only two.

The author is clearly not a botanist, and the fussy professional will note disapprovingly several minor but sometimes irritating slips. She speaks repeatedly of families when she means genera. She states that the "Natural Order of the Compositae" comprises "upwards of 9,000 species, or a tenth of the whole vegetable kingdom—most of them 'a horde of barbarians which no sane gardener would admit within the boundaries of the refined circle of the cultivated Flora.'" While having to concede the general truth of the last quote about my favorite plant family, I must object to the figures she gives. The Compositae number well over 12,000 species and the "Vegetable Kingdom" more than 30 times that total. Latin learning apparently has sunk into decay even in Britain: there are numerous errors in the Latin names, some of them painfully crude—*Aster novi-belgiae*, *Helleborus guttatum*, *Hibiscus trionem*, *Gaillardia pulcella*. There is an error regarding *Camassia esculenta*, the American Camass or Wild Hyacinth; it was first introduced into British gardens not by David Douglas in 1827, as stated, but by Thomas Nuttall 15 years earlier. In speaking of the daylilies *Hemerocallis flava* and *H. fulva*, the author says these "are the only instances in which Linnaeus used the colour of the flower for the specific name of the plant, and it has been suggested that he thought both varieties of a single species." Linnaeus used color terms many times as specific names, though it is true that for this particular genus he did so only twice. And he quite plainly treated these two as varieties of one species, putting them under *H. Lilio-asphodelus*, only later dividing the species into two, abandoning the longer name (illegally by our present rules, under which *H. Lilio-asphodelus* must remain the name for one of the two; the Swedish botanist Hylander has recently designated *H. flava* as the one to keep the original name). It seems odd that the author should be able to consult works dating far back into the Middle Ages, but not the *Species Plantarum* of Linnaeus (1753). But hers is a popular book, though of serious quality, and the jaundiced professional eye should not be allowed to relay a hostile report on account of technical minutiae.

Though early history understandably bulks large, there are good summaries bringing down to quite recent times the evolution of some of the more complex hybrids like gladiolus and iris—information almost impossible to obtain at the present time, and certainly not available in convenient form. These do not quite come down to America's newest gifts to horticulture, the artificially induced polyploid strains of garden annuals such as Tetra Snapdragons and Tetra Phlox. American readers may be a bit miffed at the scant credit given breeders on this side of the Atlantic in the development of daylilies and some other groups. Even on the more distinctly historical side, one feels that the work of Kalm, the Bartrams, Collinson, the Frasers, and others who did so much to introduce America to Europe botanically, has been given too scant attention. But this merely points up the opportunity for a similar book dealing with the American scene. Though lacking the ancient and medieval history of European countries, there is abundant material for historical accounts of American garden subjects and the men who have introduced and developed them. A wealth of Indian, Spanish, Creole, and pioneer American plant lore is still to be tapped, as well as the now at least partly available history of botanical exploration, and the less accessible evolution of American gardening—the Downings, Thomas Meehan, Frederick Law

Olmstead (an early visitor to Texas), Luther Burbank, and recent developments with polyploids.

Perhaps the reading of Alice Coats' new book will plant the seeds of something like it for this country. Certainly it is a book to recommend. The confirmed gardener will learn pleasurably of many unsuspected facts about old and familiar friends. Even the non-gardener may browse with casual enjoyment. This may not sound particularly scientific, but there is a real link between a more cultivated awareness and appreciation of garden subjects and the progress of technical knowledge. So eminent a scientist as Charles Darwin was not ashamed of performing "idiot experiments," such as having his son play a trumpet (or bassoon; accounts differ) to sime twining vines in his garden, to see whether sound waves influenced the direction of twining, since light waves certainly affected plant movements. There is a wealth of observation on phenology, pollination, spontaneous hybridizing and mutations, which the amateur attentive to his garden could easily make. If reading *Flowers and Their Histories* brings a realization of the fact that gardening can and should be something more than the too stereotyped, synthetic, commercial thing it is in America, Alice Coats may in time be numbered among the real contributors to science.—***Lloyd H. Shinners.***

THE SOUTHWESTERN NATURALIST

INFORMATION FOR CONTRIBUTORS

Articles or short notes on subjects within the interests of the Association (see inside front cover) are acceptable. There are no size restrictions, but because of high printing costs, very few long papers and not many illustrations or tables can be published. Manuscripts should be typed double-spaced, on one side of the paper only, with ample margins. Illustrations, maps, and tables should be kept separate, mailed flat, mounted on stiff paper or cardboard, preferably not larger than 8½ by 11 inches. Legends for them should be typed on a page by themselves. Include a scale as part of the drawing if exact size is critical.

Titles should be brief but sufficiently indicative to permit ready indexing by principal subjects without the necessity of reading the entire paper. They should be suitable for translation into foreign languages. Mention family, order, or other higher taxon with scientific names if these are part of the title. Full length articles should include an abstract. Do not use footnotes if at all avoidable. Give scientific names for all organisms mentioned. List references together as end of article, alphabetically by author, several by one author chronologically. Arrange title, author(s) with mailing address, abstract, body of paper, and references in that order.

Reprints are furnished at cost. An order form will be sent with proofs. No free copies of the journal are supplied to authors.

Address manuscripts and inquiries to:

LLOYD H. SHINNERS
HERBARIUM
SOUTHERN METHODIST UNIVERSITY
DALLAS 5, TEXAS

CONTENTS

General

Significance of orthogenesis in angiosperm taxonomy. *Arthur Cronquist* 97

Zoology

Summer foods of some fish species in East Bay, Texas. *George K. Reid, Anthony Inglis, Hinton D. Hoese* 100

Dimorphism and cannibalism in tadpoles of *Scaphiopus bombifrons* (Amphibia, Salientia). *Arthur N. Bragg* 105

Fossil rabbits (Lagomorpha) of the Friesenhahn Cave deposit, Texas. *David Pettus* 109

Botany

Bryophytes from Guadalupe Island, Baja California. *Howard Crum and Harvey A. Miller* 116

Phenology of spring weeds in Norman, Oklahoma. *Wm. T. Penfound* 121

Chromosome numbers and geographic distribution of *Lindheimera, Engelmannia,* and *Berlandiera* (Compositae-Heliantheae-Melampodinae). *B. L. Turner and Marshall C. Johnston* 125

Notes

Blowguns for reptile sampling. *Donald W. Tinkle and William C. Lawrence* 133

A modified Berlese funnel for collecting mammalian and avian ectoparasites. *J. A. Sealander and C. E. Hoffman* 134

Effectiveness of Japanese mist nets for securing bats in temperate latitudes. *Bryan P. Glass* 136

An arboreal nest of the five-lined Skink, *Eumeces fasciatus,* in eastern Texas. *J. P. Kennedy* 138

Reviews

A manual of parasitic Mites, by Baker, Evans, Gould, Hull, and Keegan. *R. W. Strandtman* 140

Gamazovye Kleshchi (Gamasoidea), by N. G. Bregetova. *R. W. Strandtmann* 140

Flowers and Their Histories, by Alice Coats. *Lloyd H. Shinners* 142